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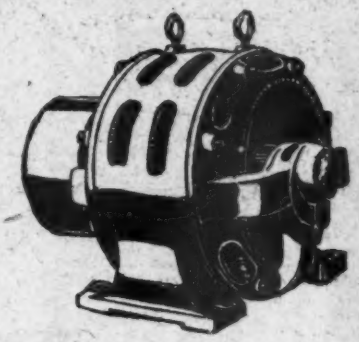

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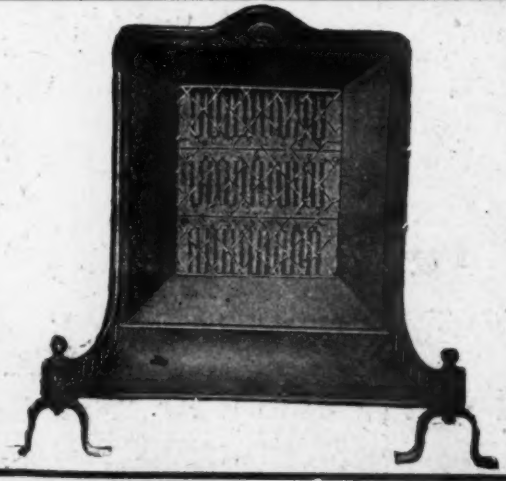

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ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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PUBLIC SERVICE CONTROL.

As we have had occasion lately to refer to the public control of public services operated by companies, it may be of interest to consider briefly the system as practised in the United States, where the great majority of the electricity supply and tramway undertakings are in private hands. The plan usually adopted is to appoint a "Public Service" or "Public Utilities" Commission consisting as a rule of three or five members, to regulate the services of the particular State concerned; the Commissioners are salaried officials, and are armed by the State Legislature with the powers necessary for the performance of their duties. While some States have possessed such Commissions for over 20 years—created originally to deal with railway matters—others have followed their example only within recent years, and some appear to have taken no steps in this direction. The duties, as well as the powers, of the Commissions vary widely; some have control only over railways, others deal with all kinds of public "utilities," prominent amongst which, of course, is electricity supply. The Commissions investigate the income and expenditure of the companies operating under their supervision, and regulate the scale of profits, as well as the relations between the suppliers and consumers. A few examples taken from the *Electrical World* will serve to illustrate their methods:—

"Urging the need for co-operation between central-station companies and their patrons in small communities, the Montana Public Service Commission, instead of granting increased rates to the Eastern Montana Light & Power Company at Wibaux, recommended the establishment of dusk-to-dawn instead of twenty-four-hour service."

Here the Commission exercised control over the operation of the supply undertaking.

"The Public Service Commission of Pennsylvania ordered the Eastern Pennsylvania Light, Heat & Power Company to desist from the practice of requiring deposits to cover the costs of making service connections, holding that electric lighting and power companies are not justified in demanding that a prospective consumer supply capital for the labour and material required to make such a connection, and that they are sufficiently protected by the right accorded them to require a deposit from the customer to secure payment for electrical energy delivered."

This instance will be of special interest to the apparently large number of British communities from which complaints of excessive service charges emanate. The same applies even more forcibly to the following example:—

"In passing upon a new rule of the New Jersey Public Service Electric Company requiring the cost of service connections to be borne by the customer, the New Jersey Board of Public Utility Commissioners refused a change in the rule as to the former free limit and also held that where charges are permissible they should not be fixed sums but based on actual cost of materials and labour."

This case bears a close resemblance to a number that have been brought to our notice in this country.

"A provision in a franchise requiring an electric company to furnish electricity for lighting city buildings free of charge should be eliminated, the North Dakota Board of Railroad Commissioners has declared, since the expense of such service should be borne by all citizens benefiting therefrom and not entirely by the consumers of electrical energy."

It will be noticed that the Railroad Commissioners are mentioned in the foregoing example; it often happened that the Commissioners were appointed in the first instance to deal with railway and tramway affairs, and that their powers were later extended to cover other public services. The Commissioners rightly veto an at-

tempt to levy tribute from a supply company, clearly seeing that the charge must be passed on to the consumer.

"The Georgia Railroad Commission . . . found a return of 6 per cent. too low and endorsed rates designed to yield 8 per cent."

Here the Commissioners recognise the right of the supply undertakers to a fair profit. How otherwise can capital be attracted into the industry?

"In arranging an increased rate schedule for the municipal electric plant at Kiel, Wis., the Railroad Commission of that State found that under existing conditions an increase of 60 per cent. was necessary."

The Commissions hold the balance evenly. In normal times they take care that the charges are lowered as the undertaking develops, but under the existing conditions the pendulum necessarily swings the other way; their function is not to oppress the supply company, but to secure fair play for both parties.

"Granting a revised schedule of electric rates to the Heppner Light & Water Company . . . the Public Service Commission of Oregon insisted that more satisfactory service must be provided and recommended the immediate installation of a voltage regulator at the generating plant."

Here faulty service earns a reprimand, together with a technical suggestion as to the best method of improving it.

So much for the mode of procedure of the Commissions. These examples all appear, with others, in one issue of our contemporary, and similar ones are published every week, indicating that the Commissions are constantly exercising their powers. That their work is regarded with approval and satisfaction by the public is attested by the results of a questionnaire published in the same issue of the *Electrical World*. It appears that in two States (Arkansas and Illinois) the services of the Commissions were disparaged, and in the State elections last November the opponents carried the day. The ground of the attack was the grant of increased rates to the supply undertakers, which was seized upon by the politicians as a lever with which to dislodge the party in power. In this country it has been necessary to grant increased statutory maximum charges to both municipal and private supply authorities, after the undertakers had progressively raised their prices to the maximum previously authorised. In the United States apparently there was no statutory maximum; the question was whether any increase at all should have been made. The Governor of Arkansas, a staunch supporter of State regulation, made inquiries of the other Governors and received replies from 34 States where Public Service Commissions were in existence, all strongly commending the system, in such terms as the following: "Extremely useful; we would not think of abolishing it." "We consider it an indispensable department. . . . It saves our industries and people hundreds of thousands of dollars annually." "An important and necessary adjunct of the State Government." "Its actions almost without exception prove to have been warranted." "Its work has been of incalculable benefit to the people of our State"—and so on.

The system is undoubtedly endorsed by the public; is it resented by the industry? Presumably the latter would naturally prefer to have an entirely free hand—but that is impossible, either in the United States or in this country. On this point our contemporary remarks: "State regulation has not been entirely to the liking of public utilities. Commissions have, as a rule, favoured the public more than the service companies, so that on the whole as agents of the people they have been effective." The *Electrical World*, however, regards the efficiency of State regulation as proved, and scouts the idea that, even in the two States named above, Commission regulation will be abolished. It declares that "State regulation has justified itself, and is too firmly rooted to be dislodged by the political assaults of misinformed demagogues." Evidently, therefore, our contemporary accepts the Commissions as being on balance decidedly advantageous.

Turning to the conditions obtaining in this country, we may note that more than half the industry is in the hands of municipal authorities, whereas in the United States these are in a small minority. Parliament has from the first exercised a tight control over the whole industry by special legislation and through the Board of Trade. Of the earlier Acts, little good can be said, and it is clear that general legislation may have disastrous results. Even the Temporary Increase of Charges Act was a scandalously unfair and oppressive measure. But it will be seen that public control in one form or another has been in force since 1882. Now the conditions are changing; a central board of Electricity Commissioners has been appointed, with very wide powers, which will be amplified if the Electricity (Supply) (No. 2) Bill becomes an Act, and this board comprises members who are intimately acquainted with the technical and commercial conditions under which the industry is carried on, so that its decisions will be based on competent knowledge and not (we hope!) upon political grounds. Whether the Electricity Commissioners will be able to shoulder the whole burden of regulating supply in every district, in addition to their many other duties, is questionable, but they are empowered to set up Advisory Committees, and at least they can act as a final Court of Appeal in disputed cases. Two important companies in Wales and Yorkshire have declared their readiness to operate under the control of the Electricity Commissioners, if authorised to discharge the functions of Joint Electricity Authorities, and doubtless other Power Companies would willingly accept similar conditions. This system, therefore, offers a solution to the great problem which now confronts the industry, a solution which would short-circuit many of the extremely perplexing difficulties that have cropped up directly the attempt has been made to inaugurate the scheme of the Act of 1919. Provision for its adoption has in fact been made in the No. 2 Bill now before Parliament. Such a course would enable development to commence at once; if we wait for the proposed Authorities, it is clear that progress will be delayed for years to come.

We may point out that the proposals of the North Wales and Yorkshire companies are in no sense inimical to the existing municipal supply undertakings; the latter, where able to generate economically, will continue to do so under either of the schemes, and where they cannot establish that claim, they will become distributors of bulk supplies also under either scheme. Bulk supply, in fact, will be the main business of the Joint Electricity Authorities or of the Power Companies, whichever be called upon to operate.

An important point, which was admirably brought out in the report of the conference of Yorkshire authorities to which we recently drew attention, is that the power companies own their rights in perpetuity. They can therefore be purchased only by agreement, involving a heavy capital charge; or allowed to carry on side by side with the new Authorities, involving immense waste of capital and loss of efficiency; or dispossessed by new legislation, involving what amounts to confiscation. And the whole thing is so utterly unnecessary!

The Baltic Provinces and their Industries.

The United States Department of Commerce has issued as a supplement to the customary commerce reports a long report prepared by Mr. Boris M. Baievsky, dealing with the agricultural, industrial, shipping, railway, and other economic conditions in the Baltic provinces of the former Russian empire, namely, Esthonia (Estland), Livonia (Lettland, Lettonia), and Courland (Curonia). The report contains very little of an electrical nature, but such information as may be worthy of reproduction is given below.

It is explained that Esthonia possesses 648,000 acres of peat moors, the depth varying from 2 to 6 metres. Various projects for the working of the peat have been drawn up during the past few years. Among these was one prepared by the Manufacturers' Association in Reval, which provided for the erection of a generating station that would supply electrical energy to the whole

of the Reval industrial area. The capacity of the station was to have been 15,000 kW, and overhead wires were to be used with transformers at various points. It was impossible to carry the scheme into effect owing to the lack of funds, as all the machinery and plant would have had to be imported from abroad, and this would have required more credit than was obtainable at that time. It is added that there are also sufficiently extensive peat moors in private hands to warrant the erection of large generating stations.

After mentioning the number of industrial establishments, the number of workers employed, and the value of the products turned out in the three provinces in 1908 and 1912, the report gives a list of the metal, machinery, and shipbuilding works existing in 1913, which had always been compelled to obtain raw materials from abroad and from the interior of Russia. Among the works mentioned are the Volta Electrical Machinery Works of Reval, Esthonia, the Universal Electricity Co. of Riga, Livonia, the Riga municipal power station and the Riga Tramway Co., and the Continental Electric Traction & Lighting Co. of Libau, Courland.

Before the war Riga, Livonia, was the seat of the Baltic and the Phœnix Car Works; there were also large machine shops, locomotive works, and some 400 manufacturing plants. As a manufacturing centre, Riga suffered heavily when in 1915 the Russians stripped the works and transferred much machinery to the interior, including boilers, machine parts, and electrical apparatus. As long as the future of the Russian market is undecided and there is difficulty in obtaining fuel and other raw materials, machinery and capital, only small undertakings seem possible at Riga. The former Baltic provinces are administered as two republics—Esthonia and Latvia. In February, 1920, peace was concluded between Esthonia and Soviet Russia. Under the terms of the treaty no customs or transit duties are to be levied on goods passing through Esthonia, a free port for Soviet Russia is to be established in Esthonia, and the right is granted to the latter to construct a railway from Reval to Moscow and to work 2,700,000 acres of forests. On the other hand, the utilisation of the Narva waterfalls for electric power production is granted to Soviet Russia. The plant of the Volta Electrical Machinery Works was entirely transferred to Moscow on the approach of the Germans. Before the war the company produced electrical apparatus, dynamos, motors, transformers, and electrical cranes, and 600 workmen were employed at the works, which is said to be well laid out for electrical manufacturing on a large scale. After dealing with the shipbuilding yards at Reval and their equipment, the report refers to various proposed new railways in Esthonia, and concludes with a discussion of the general economic situation of the Latvian republic.

Some striking examples of the decline in production in Russia under Soviet rule were published recently by the Russian official journal *Pravda*, thus confirming the statements made some time ago by a German engineer under the title of "Russian Electrical Industry during and after the War." (Electrical Review, October 29th, 1920). The journal states that whereas the output of teleghaph instruments by the Ericsson Co. in 1916 was 10,000, in 1921 it only amounted to 250. In the case of machines the Siemens-Schuckert Co. supplied generators, &c., of a total of 14,000 kW in 1916, but is now only able to turn out 6,000 kW per annum; the united cable factories, which formerly consumed 210,000 poods of copper per annum, now only work up 25,000 poods; and the production of Morse apparatus by the Siemens & Halske Co. has declined in the same period of years from 7,500 to 150. The journal attributes the retrogression in the industry to the scarcity of labour, as the number employed has fallen from 30,000 to 6,000, of whom only 10 to 20 per cent. represent skilled workmen, as compared with 75 per cent. formerly.

A further statement on the situation in the South Russian coal and iron and steel industry has just been made by an engineer who recently returned from that district. He states that the scarcity of efficient electric motors at these works prevents the pumps and other plant from being worked, and that many motors lie about the works awaiting repair, but there is a complete absence of wire and insulating materials and of electrical apparatus in general.

"Superpower."

In this country we are overworking our long-suffering Electricity Commissioners with the object of developing, as quickly as possible, our resources for the supply of abundance of power to our industries, in order to increase the output of manufactured products per worker per annum, and thus to retain our share of the world's markets. Across the Atlantic precisely the same process is in progress, and for precisely the same reason! Although in the United States no less than 3½ h.p. is used per head, about twice as much as in this country, it is held that in view of the feverish activity of European countries in bringing up their power utilisation towards that figure, and the lower wages paid in Europe, the use of mechanical power must be quickly developed to a far higher degree.

The policy adopted, which is succinctly and comprehensively styled "Superpower," is in the main very similar to ours, except in respect of the appointment of Electricity Commissioners. The densely populated North Atlantic seaboard has been selected for first treatment; although it comprises only 2 per cent. of the total land area, it contains 22 per cent. of the population, and produces nearly 40 per cent. of the manufactures of the United States. This, then, is the first "superpower region," which has recently been the subject of an extended survey. Within this area it is intended to link up the large power stations with heavy trunk mains, to erect large steam-driven generating stations, and to develop water-power resources which could not be profitably utilised without the linking system. Inefficient installations will gradually be abandoned, and the larger and more efficient ones will be incorporated in the network. In fact, each "superpower region" will become a huge power reservoir into which all the power will be dumped, and from which all the industries will draw their supplies in bulk. Obviously the root idea is identical with that which is in course of development here—all too slowly.

The estimated consumption of 1920 for manufacturing purposes was 12,400 million kWh, of which the central stations supplied only about 2,750,000,000; by 1930 it is expected that the consumption will be 19,000,000,000 kWh, of which 10,000,000,000 will be supplied by the "superpower" system, effecting a saving of 53 million tons of coal per annum. There, as here, during the war the manufacturer turned to the central station for power supply as he had never done before; and there, too, the capacity of the manufactories was increased far beyond the requirements of the home markets, so that export is essential.

In the decade between 1904 and 1914 the power installed in U.S. factories increased from 2.5 to 3.2 h.p. per head, and it is now estimated to be 3.5 h.p. In this country, in 1907, the value was only 1.55 h.p. In 1904-1914 the output of manufactured products per worker in the United States increased from $2,700 to $3,430 per annum; in the United Kingdom in 1907 the corresponding figure was only $1,220 per head per annum.

It is interesting to note that the Superpower Survey has recognised as a fundamental principle that the rights and property of the existing public "utilities" must be respected and safeguarded; the system will be restricted to power stations and main transmission lines, giving a supply of electricity in bulk.

An interim report on the subject was recently submitted to President Wilson by the Secretary of the Interior; it contains many features of great interest, to which we shall refer in a later issue.

THE FUNCTION OF WHITLEY COUNCILS IN THE ELECTRICITY SUPPLY INDUSTRY.

By J. W. THOMAS, B.Sc., A.M.I.E.E.

The present industrial situation is causing considerable perturbation in the minds of many thoughtful people both inside and outside the engineering profession. On the one hand they see wages soaring beyond what appears to them to be reasonable limits, and on the other an increasing amount of unemployment, and one is not surprised to find that they take the easy step to the conclusion that the latter is largely the result of the former. The vicious circle of rising wages and rising prices which has been created, has, in their opinion, overstrained the industrial machine, with the result that it has ceased to function normally. Not a few go so far as to openly advocate that the only way to break the circle is for labour to consent to a reduction in wages. Their argument seems plausible, but the less sanguine ones, whilst not disagreeing that there may be something to be said for their contention, recognise that the remedy is much too simple to be effective, and that it leaves out of account many other relevant and important factors. High costs of production and the decline in trade, to which some of the present unemployment may be attributed, may not be due entirely to high wages, but to lessening productivity per unit amongst the employés. In fact, in the opinion of many prominent employers, it is this factor rather than wages which is the most important, and the most disquieting feature in industry at the present time. It is, in a word, the failure on the part of the workers to produce what might reasonably be expected from them. The average working man has come to look upon himself as the victim of a soul-less capitalistic system which is for ever grinding him down and exploiting his labour, and it is not unnatural to find that he is resolved to do as little as he can, and to get as much as he can for it. Employers complain that the service performed by their employés is often both grudging and meagre. Moreover, there is a lack of discipline and of respect towards those in authority. The readiness to respond to orders seems to have diminished, and there is a marked attitude of greater independence when contrasted with what obtained a decade or so ago, when the word of the employer was law, and when his commands were obeyed promptly and without question. As a consequence there is a decrease in the efficiency of production, and it is this symptom in industry which is the most alarming, and which calls for very special attention.

Those whose business it is to direct industry are increasingly incapable of controlling those who are called upon to do the work. In former days, before trade union organisation had reached its present stage, the workers were compelled by the fear of unemployment to carry out the behests of their master without question. If they refused to do his bidding they were dismissed, and had to face the workhouse. Rather than become destitute they were obliged to submit to a discipline which, in these days, would seem intolerable. Some few humanitarians denounced the system as inhuman, but its supporters justified it on the grounds that it was efficient, and that it enabled the employer to get his work done cheaply and efficiently. In these days, when practically all the workers are in protective organisations, the average worker has not the same fear of absolute starvation, partly because he knows his union will assist him during periods of unemployment and partly because to-day the State will not allow the workers to reach the stage of absolute destitution lest there should be a social upheaval. Consequently the old stimuli fail to evoke the same response in human effort. In well organised industries where the employer once commanded he has now to cajole. His absolute authority has been considerably curtailed. He cannot pay what wages he likes, or force his workmen to work more hours than they collectively agree to. Nor can he dismiss arbitrarily those whom he employs or even engage those to whom the workmen take exception. In fact, on more than one occasion the employer has been compelled to dismiss one of his officials on account of the pressure from the unions. In all directions, therefore, he finds himself hampered and crippled and, what is most important, he cannot compel his workers to work harder than they think proper. In short, the old system has ceased to be efficient. It is idle to attribute its failure to the selfishness of the working classes. They are probably no more selfish than their masters. The fact that there appears to be throughout industry a declining motive for economic effort should compel us to inquire whether the fault may not be in the system itself, and to examine whether new motives cannot be discovered. It is obviously foolish to think that mere exhortations to the workers to produce more will have the desired effect. The workers have passed the stage when they were willing to be the docile instruments of the masters, and have learned that they possess power of which in the past they never dreamed. If the motives on which the industrial system has been accustomed to rely to secure efficiency secure it no longer, other motives must be found. Their discovery is largely a matter of psychology. It has already been hinted that the greatest hindrance to effective and willing work is the suspicion in the minds of the workers that their toil is simply to provide profits for the employer, and that greater exertion above a certain recognised standard merely increases the gain accruing to the shareholders. The competitive system in industry is to some extent responsible for this. It has tended to obscure the vital truth that industry is primarily concerned with public service, and that those who labour in it are performing a necessary function for the community. Particularly is this true in the electricity supply industry, though it is an aspect which both employers and workers have yet failed to grasp. Let them once come to feel that they are not helpless and irresponsible pawns in a game of "grab," but workers contributing their quota to the public well-being, and a new interest will be generated. Furthermore, having recognised their powers, the workers must also be given some responsibility for the maintenance and efficiency of the service. This sense of responsibility can only be aroused in so far as they are given a more direct participation in the administration of the industry in which they are engaged. The proposals to form Whitley Councils in various well-organised industries were put forward by the signatories to the Whitley Report with a view to enabling the workers to have, through their organisations, an increasing share in the management of their industry, and to stimulate them to take a more direct interest in its efficient working. It is unfortunate that, up to the present, few of those which have been set up have attained to this ideal. The majority of them, if not all, have become largely wages boards, and their main occupation has been to secure increased remuneration for the employés. In hardly any case has the efficient administration of the industry as a whole been taken seriously. The fault of this is not to be laid entirely at the door of the trade unions, some of it is no doubt due to the reluctance on the part of the employers to alter their customary practice of managing their own affairs in their own way. Many of them have still to be persuaded that the corporate feeling existing amongst the workers, as manifested in their organisations, is not wholly an evil thing. On the other hand, the trade unions themselves are by no means blameless. They have not recognised their responsibility to the industry of which they form a part, and have been more concerned to extract something from it than to put something into it, or to see that their labours were not

dissipated by a feeble and inefficient administration. This is as true in the electricity supply industry, where such Councils have attained to a certain maturity, as in any other. Both sides have yet to realise that the object of the industry is to provide the community with service, and that in the task of providing that service both have a collective responsibility. It is no exaggeration to say that the active and constructive co-operation of the employés would do more to increase the efficiency of the supply industry than years of invention. Manufacturers to-day will compass sea and land, and engineers will "scorn delights and live laborious days" in order to improve the efficiency of their machines by one or two per cent., whilst all the time ignoring the latent capabilities of the human element, whose enthusiastic service and co-operation enlisted on behalf of the industry would make the former increase of efficiency pale into insignificance. This co-operation on the part of the employés, through their organisations, can only be secured by the cultivation of what might be described as professional pride. It has always been recognised that the foundation of efficiency in what are known as "the Services" is the *esprit de corps* which animates all ranks, and every means is taken to encourage it. A like spirit needs to be engendered in those who are engaged in the supply industry. There is no reason why the performance of so important a function as the supply of electricity to the community should not be looked upon as being equally honourable as those professions which are concerned with war, and why the same spirit should not be encouraged. It can only be cultivated, however, in so far as the workers feel that they are not merely "hands," but human beings, capable of assuming responsibility, and of contributing to the welfare of the industry as a whole. But responsibility implies power, and it is the function of Whitley Councils to provide machinery, whereby the workers are given such power to co-operate in the general management of the industry, and to voice their views on its administration.

This is the most vital aspect of the matter, as it is obvious that such a delegation of power will involve a fundamental change in the position of both employers and trade unions. Instead of being merely defensive organisations concerned with the maintenance or the uplifting of the workers' standard of life, a kind of permanent opposition in industry, they must become part of the government. There are, of course, many employers who would scoff at any such change as this, and would strenuously oppose any interference in what they claim to be the employers' province. But such opposition is both out of date and futile. If they expect the workers to give of their best they must be prepared to concede to them their claim to be treated as human beings. The employers cannot have it both ways. The enthusiastic service of willing brains can only be secured when the employers are prepared to treat the workers as if they possessed brains and are given sufficient control in the conduct of the industry to stimulate them to give of their best in its service. Furthermore, during the war many of the workers realised a certain amount of power, though perhaps of a negative kind, and it is no more to be expected that they will be content to return to their former state of docility as irresponsible instruments of production, than it would be for Adam, having tasted the fruit of the Tree of Knowledge, to return to his original state of pristine innocence.

The hands of the clock cannot be put back. It would be a most short-sighted policy on the part of employers to shrink from granting increasing power to organisations of workers for fear lest they should become tyrannous or exploit the public. As one economist has put it: "It would be to pour away the baby with the bath and to lower the quality of the service in an attempt to safeguard it." The wise employer will endeavour rather to make use of these collective groups and to enlist their corporate strength on the side of increased efficiency in industry.

There is one aspect of the trade union movement, which even to-day does not appear to have been recognised by either employers or the public, viz., their capacity to foster the feeling of loyalty to the group, and to secure the loyal obedience of the members to their leaders. On more than one occasion the writer has been struck by the loyalty of employés to their group or trade union. When faced with the choice of duties they have chosen to follow the leadership of their trade union official rather than carry out the instructions of the employers, and this, be it noted, not when any financial considerations were at stake, but solely questions of principle. It would be a fatal mistake to attempt to conquer this corporate spirit, it must rather be rightly directed so that the loyalty to the trade union may be made to serve the good of the industry as a whole. The frequent occurrence of strikes or threats of strikes in the supply industry is sufficient indication that this corporate pride in the industry has not been harnessed as it should have been, largely, no doubt, because the machinery has been lacking.

When the machinery for giving the workers larger control is in operation the trade unions will have to learn that it is their duty to instil into the minds of the workers the necessity of goodwill and zeal in the public service. The excuse that they cannot serve with enthusiasm capitalistic employers, who have no other interest in them than to make profit, has no validity in the case of municipally owned services. In such services they without question are the servants of the community. Moreover, if their claim to have a greater control in the conduct of the industry is to be justified it can only be so on the grounds that the result is a more effective service than was possible in the days when their responsibility was negligible. The workers cannot have it both ways any more than the employers; they must either by an increase in internal discipline amongst their members, produce a change in the efficiency of the industry, or else qualify their demands for increasing control.

The immediate practical problem, then, is how the machinery for carrying these proposals into effect is to be set up. Few will deny that useful as the present Joint Councils and Joint Boards have been in the supply industry in dealing with questions of wages and conditions, they have failed to achieve the real purpose for which they came into being. Nor is it open to much doubt that with their present composition they will be unable to achieve much more. In the first place, neither the Joint Councils nor the Joint Boards completely represent all those who are engaged in the industry, nor is there sufficient co-ordination to enable both the Councils and the Boards to work for the good of the industry as a whole. It is not to be expected that such large questions as administrative and technical efficiency, the consideration of improved methods and organisation, the improving of the status of the industry, legislation, employment, &c., can be adequately dealt with either, on the one hand, by a Council on which only the manual workers are represented, or, on the other, by a Board on which only the staffs are represented, and even here only inadequately, as there is now the attempt to exclude the clerical and administrative staffs.

It is extremely unfortunate, in the writer's opinion, that the employers on the National Joint Board are insisting that the clerical and administrative staffs should not be represented on the National Joint Board. It is shutting the door in the face of progress, and will have the effect of converting the Board into nothing more than a wages board. It is still more unfortunate that the unions representing those staffs have not composed their differences and agreed that, as they have an interest in the welfare of the industry, they have also a right to be represented on the Council which deal with it.

It may be laid down as axiomatic that if the good of the industry and the welfare of those who are engaged in it are to be considered with any hope of success, it can only be in so far as all who are engaged in the industry meet together round a common table in a spirit

of goodwill and co-operation. Not until machinery to provide for this is set up will Industrial Councils in the industry fulfil their true function. There are, of course, many reasons to be advanced why the operative unions and the supervisory unions should have separate Industrial Councils, especially where questions of wages and conditions are being discussed, but there is no possible reason why both should not co-operate on broader issues. With such joint machinery in being, the workers would have the benefit of the special technical knowledge of the staff, whilst the latter would come to understand more intimately the needs and capacities of the workers, and would in many cases act as a steadying influence. With such united co-operation the idea of purpose in industry would also become more apparent. It is because this idea has been obscured, and because industry has been regarded more as providing opportunities for personal gains than for public service, that the economic life of to-day is in a perpetual state of unrest. It has become a tug of war in which those whose economic force is greatest receive the largest prize. If the conditions which produce this unnatural tension are to be removed there must be a new orientation which will give primary consideration to the purpose for which the industry is carried on. It is high time, in public services at least, that the atmosphere of antagonism and conflict should give place to that of co-operation towards a common end. When such an environment exists, many of the problems which now appear insoluble will admit of treatment on simple lines, and many of the fears of the public regarding the greed of organised bodies will be laid to rest.

Doubtless many of the above suggestions will appear Utopian and idyllic to the practical or conservative. Time will show that their realisation is not merely probable but inevitable. Industry is at the parting of the ways when the old methods are breaking down and when the only new method available is the enlisting of the active interest of the workers, by granting them, through their organisations, a great voice in the control of their working lives, greater scope for initiative, a greater degree of self-direction, and the recognition that they are partners in industry with rights and responsibilities, as a substitute for the autocratic control of the employer. If such an alternative is to be adopted it will require on the part of those in authority, faith in the capacity of their employés to rise to the level of their responsibilities, and on the part of the trade unions it will mean the giving up of much of their sectional and defensive outlook.

Once the experiment is made, and as experience ripens, those who represent the consumers on the employers' side will recognise the value of having the active co-operation of the workers, nor will the workers be slow to grasp the value of the training it affords them and of the opportunities of contributing to the welfare of their own members as well as of the community at large.

There is, of course, nothing to be gained by minimising the practical difficulties, but given the necessary goodwill amongst all sections, there are sufficient brains in the industry to solve them. As fresh experiments are made, new lessons will be learnt which will throw new light on those difficulties which now appear insuperable.

Whether Industrial Councils will come to be a permanent feature in industry is a question too big to be discussed here, but few will deny that the possibilities of success are as great in the electricity supply industry as possibly in any other, and that experiments in joint control by producers and consumers in municipally-owned services are more likely to be fruitful than in most others.

OUR FUTURE TRADE WITH SPAIN.

Present interest in the Spanish market centres chiefly around the projected Customs tariff revision. There is ground for the fear that the new duties will be strongly protective, though the more clear-thinking Spanish economists realise that to restrict the importation of electrical material into the country or raise its cost, will hinder the nation's industrial progress in the many directions where electric power is vital to activity and efficiency. Spain is short of coal, but has almost unlimited water power, and the future of her railways must depend on her development of this power for electrical purposes.

Powerful interests are at work to obtain protection by higher import duties for any infant electrical industry, added to which the Government is faced with the need to increase its revenue and maintain a favourable trade balance. It will, therefore, require all the energy and influence of our own Board of Trade, the Federation of British Industries, and the British Chamber of Commerce in Spain, each of which is watching British interests, to ensure that our manufacturers are not too severely handicapped in the Spanish market.

A little comfort is derived from the fact that the new rates were not settled by the date originally announced (March 21st), and from the practical certainty that the most-favoured-nation treatment formerly accorded to Great Britain will be continued under the new arrangements. The secretary of the Spanish Chamber of Commerce in London recently stated that in the case of Great Britain, and in that of France also, it is possible that the intended increases will not come into force, because at the present time the respective Governments are already engaged in drafting the new commercial agreements between Spain and those nations.

It is interesting to read the British official view on the future of our trade with Spain. In the report just issued by the Department of Overseas Trade, H.M. Commercial Secretary at Madrid says that even with the protective measures demanded by the Catalan and Basque manufacturers, the Spanish market will not be closed to the foreigner owing to the fact that Spain is still unable to supply its own increasing needs.

With the acknowledged preference for British materials and manufactures, the future of British trade with Spain should be assured provided that sufficient study is made of the requirements of the country. In this connection it is noteworthy that exports from Spain to the United Kingdom show 160 per cent. increase in value in 1920, as compared with 1913, and exports from the United Kingdom to Spain show 146 per cent. increase in value in the same period.

Effect of Normal Competition.

While it cannot be doubted that the war brought great wealth to Spain, it is clear that, as a nation, she has not emerged with that prosperity that should have been the result of her neutrality and her wonderful natural resources. While lacking what may be called the spirit of commerce, to give the Spaniards their due, it must be allowed that during the war they showed great commercial activity. As a result of this activity they experienced a period of unprecedented prosperity, which if it had been maintained would undoubtedly have given a great impetus to industrial enterprise. That they did not maintain it is, however, clear from a comparison of their trade balance at the end of the first ten months of 1920 with that at the end of 1919.

Industrial troubles, lack of transport, and other factors, have all helped towards creating this result, but not a little is due to the fact that every issue in the country is more or less dominated by politics.

The Spanish manufacturer early in the war found himself called upon to supply quantities of goods and foodstuffs to the belligerents, and profited accordingly. This naturally brought increasing wealth to all classes, and the increasing purchasing power of the individual created a demand for all classes of commodities in greater quantities and higher qualities than had ever been known before in the country. The Spanish banking institutions experienced increasing prosperity and the country at the cessation of the war was exceedingly prosperous.

With the return of peace, Spain found herself face to face with the fact that the demand for her goods was less, that her manufacturers were no longer free from competition,

and that her output was decreasing owing to labour difficulties, with the result that her exports began steadily to decline and her imports, largely of what may be called luxury articles, increased, until, as a result of ten months' trade, her balance is once more unfavourable. Nevertheless, a spirit of independence has been created during the war, and the 1920-21 period is marked by an endeavour to establish that independence by increased taxation against the foreigner, and a tendency towards the nationalisation of Spanish industries.

After foodstuffs, the largest class of imports is that which includes machinery, electrical material, ships, and motor cars. In this class the increase in 1920 over 1919 is 120 per cent., and compared with the year before, 300 per cent.

Especially interesting is the trade in electrical material, motor cars and lorries, and agricultural machinery. Of all these goods, for which the demand may be expected to become increasingly active, the U.S.A. is at present the largest supplier. The import of dynamos and electric motors in 1919 was 3,100 tons, more than half from the U.S.A. Eight hundred tons came from Switzerland. The United Kingdom provided 340 tons, Sweden and France the remainder. France follows the U.S.A. as the second largest source of accumulators. In electric cables the United Kingdom is second. The U.S.A. is also first in carbons. Electric lamps are obtained chiefly from Holland and the United Kingdom.

The impetus received by Spanish industries during the war reached a climax in 1919. The nation had become increasingly self-dependent. The textile industry was strongly established. Electrical goods of good quality were being made at Saragossa. Motor spirits were distilled in Spain from shales and lignites. The national coal and iron industries were developed to a notable degree. Last year, however, witnessed a set-back to Spanish manufacturing industries, a reduction of the lead gained during the war by the United States, and a remarkable revival of German commerce.

In her own market, however, Spain is very much to be reckoned with in the iron and steel industries. If the iron and steel manufacturers succeed in their efforts to get increased protection, they will oust foreign competition almost completely. Other manufactures which are produced in Spain on a competitive scale include accumulators.

American and German Activities.

Although the considerable lead gained by Americans during the war has been increasingly reduced, imports from that country have nevertheless been larger than ever in actual quantity. But their keenness is unabated. They have established direct freight connections. They have distributed widely catalogues printed in Spanish. They have made a free use of the Press. They have cut prices. They no longer insist absolutely on cash terms.

On the other hand, they are no longer the only country fulfilling orders. They have experienced great difficulty in getting return freights, and Spanish bottoms now suffice for their traffic with the largest port of Spain. During the second half of 1920 their trade with that country has fallen off in almost every class of imports except petroleum products. But their hold on the market remains very strong in machine tools, hand tools, and electrical goods.

German manufacturers have reappeared in the Spanish market on a surprising scale, especially in hardware, machinery, machine tools, cutlery, and electrical material. Favoured by the low value of the mark, it is evident that the Germans are out to do their level best to capture the Spanish trade. Despite the great reduction of the German merchant marine, a line of steamers from Hamburg has been specially assigned to the Barcelona route, and numerous German agencies have been established at that port for the sale of small goods. American salesmanship has improved, but other nations have again something to learn from the efficiency and thoroughness of the Germans. Their showing at the recent Barcelona Fair (October-November, 1920) exceeded that of all the other foreign nations put together. They were offering delivery within 24 hours, as four vessels loaded with the goods that were being shown at the Fair had already arrived in the harbour from Hamburg in readiness for delivery!

Spain naturally buys as much as she can from her nearest neighbour, France, and that country has furnished considerable supplies of accumulators, electrical material, armatures, machine tools, and telephonic and telegraphic apparatus.

Electrical material, cranes, hydraulic motors, and other machinery have been supplied by Switzerland, telegraphic and telephonic apparatus by Sweden, and electric lamps by Holland.

The Commercial Secretary has no doubt that British goods only need to be pushed in the Spanish market to recover much of the ground lost during the war. But they *do* need to be pushed. A very important point is that the Spanish market demands that stocks should be held in the country.

(To be concluded.)

A Vienna Telephone Factory.—The Vienna telephone works of the German Telephonfabrik A.G. Berliner has been converted into an independent Austrian company, under the title of the Oester Telephonfabrik A.G. vorm. J. Berliner, and with a share capital of 15,000,000 crowns.

ITALIAN ALABASTER.

Although the application of alabaster to lighting purposes is of comparatively recent introduction, this mineral has been used for other purposes from the very earliest times; but it required the discovery of a powerful illuminant such as electric light to bring out the crystalline beauties of alabaster to the full.

Just as electric light has come to stay, so have alabaster bowls, or "lamps," as they are always called in Italy. The same may be said of various other lighting accessories in alabaster, of which some of the small table lamps are probably the most attractive.

Italian alabaster is now reaching this country in steadily increasing quantities, and the following is a brief account of its characteristics, which has been communicated to us by the New Italian Art Association, Ltd., 38, Newman Street, London, W. 1.

Alabaster occurs in nodules, or "blocks," as they are known to the Italians, of very varied size and in shape mostly roundish or oval.

Obviously it is only the largest blocks which can be used for sculptural objects of any size or for lamps of the larger diameters, such as 22 in., 24 in., and above. The blocks are sold by weight, size being taken into account. It is not only in the *size* of the blocks that there is great variation. There are to all intents and purposes three *qualities* of alabaster; the two most important being the pure and unblemished white, or "statuary," variety, which is known as Castellina, and the white with grey markings and veins, which are often very beautiful, called Scaglione. The third variety is of a decided grey colour throughout, somewhat like figured marble, and designated Bardiglio. All three varieties are sufficiently soft to be readily cut by a saw, and they can be worked both on hand and power lathes with comparative ease and freedom from splitting.

So far as lighting purposes are concerned, it is only necessary to consider the pure white and the grey-veined varieties. Bardiglio is too dark in shade for lamp-making; it can be very effectively used, however, for ornamental purposes such as in columns or pedestals.

"Castellina" is used for the best and most expensive lamps. Some of these are plain, but more often they are carved in every style of pattern from the severely plain, such as Greek key, to the most elaborate designs, of which some are conventional and others original.

It will be noticed that most of the lamps so far used in this country are of "Scaglione." In this case carving is the exception, as their chief beauty consists in the grey veining, no two lamps ever being exactly alike in this respect. The variety of the markings and veinings and the different shades of grey are, to most people, extremely attractive. In a Scaglione lamp, whilst the veining and freedom from cracks and flaws, which unfortunately sometimes accompany the veining, are important points, a good deal also depends on the shape. Some of the lamps which have found their way to this country are unnecessarily bad in this respect.

It may be mentioned that when Italian alabaster is veined it is always in some shade of grey, whereas in English alabaster the veins are reddish, or pinkish. It is therefore a very easy matter to distinguish between English and Italian alabaster in their natural state. In Italian alabaster there are, of course, various grades both of Castellina and of Scaglione, depending on the purity of colour, the luminosity, the veining, and the freedom from flaws and cracks.

Whilst the natural colours of alabaster vary only from pure white to grey, a variety of artificial colours and shades can be applied, and the Italian manufacturers claim that this colouring is quite permanent. There is every reason to believe that they have good grounds for saying so. The artificial colouring can now be done in London, and has the advantage of making it quite easy to follow a colour scheme in a room, large hall, or any other situation, or even to match a wall paper. Whilst it cannot be denied that there may be places where cream, pink, yellow, green, or other coloured lights would be extremely effective from an ornamental point of view, it is anticipated that preference will continue to be shown in this country for either the natural white or grey-veined lamps the crystalline beauties of which are, within certain limits, in proportion to the suitability and the power of the electric lamps employed, and the skill with which they have been arranged.

Certain it is that electric light can never be more delicately toned down or the light more beautifully and softly diffused than by the employment of genuine alabaster.

In conclusion, it may be mentioned that the supply of raw material gives no anxiety for the future. The quarries have lasted for centuries, and are still good for very many years to come. Any anxiety there may be arises from the demands for higher wages which are constantly being made by the Italian workers, commencing with the quarrymen. This state of affairs, however, is not confined to Italy.

The A.E.U. Secretaryship.—As a result of the recent ballot, Mr. A. H. Smethurst has, by a large majority, been elected secretary of the Amalgamated Engineering Union in place of Mr. Tom Mann, who is retiring.

THE OSRAM-G.E.C. LAMP WORKS.

A Tour of Inspection.

Since the year 1908, when it was realised that the metal-filament lamp in practical form had been invented, and the General Electric Co., Ltd., started its manufacture, the story of the Osram lamp has been one of continual progress, to gain some idea of which, together with the wonderful growth in manufacturing facilities, an opportunity was given on Friday last when members of the Institution of Municipal and County Engineers spent an instructive morning at the above-named works.

Fig. 1.—Hydrogen Gas Plant.

When certain electric lamp patents expired in 1893, the General Electric Co., Ltd., began to manufacture the "Robertson" carbon-filament lamp. Few persons, however, could have seen in the original modest workrooms at Hammersmith the germ of the spacious modern lamp factory with over 3,000 workers, some of the most ingenious automatic machinery in the world, and a Research Department which constantly links up science with industry. In 1908 the company acquired the patent rights of the manufacture in Great Britain of Osram lamps, and adjoining the Robertson lamp works the first large factory in this country for the production of metal-filament lamps was erected.

A visit to this up-to-date lamp factory is a revelation of modern skill and manufacturing methods; the factory is independent of outside aid, which fact is one of the secrets of its success. Thus the tungsten ore comes to the factory from British Dominions overseas, to be transformed eventually into filaments; the glass is made and the bulbs are blown at the company's Lemington-on-Tyne glassworks; the argon for the

Fig. 2.—Stem Fixing Prior to Exhausting.

gasfilled lamps is produced by an argon plant that was specially installed during the war period. From the Ilene works of the G.E.C. at Birmingham, again, come the brass shells for the lamp caps. Every essential to the complete lamp, in fact, is produced within the range of the company's activities.

The actual making of the lamps is an extremely interesting series of processes, which, however, is too familiar to our readers to need further description; the accompanying illustrations show the interior of three of the departments.

When the nickel wires that support the filament, which are cut and looped ingeniously by a machine, have been inserted, the "spider" is ready for the winding on of the tungsten filament; it is then "set" by flashing in an atmosphere of hydrogen, diluted with nitrogen to prevent explosion. A complete plant for producing hydrogen is included on the premises and shown in fig. 1.

Exhausting the bulb is a most important stage in the manufacture of the lamp, and although modern ingenuity enables bulbs to be exhausted six or eight at a time and rapidly tested, the speed thus attained does not sacrifice accuracy. The girls who carry out this process sit on trolley seats that run on rails, fig. 3, and are thus able to pass quickly from one set of lamps to another, and to supervise several groups with very little trouble; sensitive electrical devices indicate when the exhaustion is as nearly perfect as possible. The caps, as is well known, require the insertion of contact-pieces, and the fixing of these in position by a special insulating material of a glass-like nature known as "vitrite." This operation is carried out on an ingenious automatic machine designed for the purpose, of which several are installed at the works.

With regard to gasfilled lamps, we understand that the old round-shaped bulb with its long neck has been discarded, and the bulb in its latest form is club-shaped. It still has an elongated neck into which the hot gas can rise and cool, but the new form of bulb which has now been standardised is much easier to blow, its shape being a more natural one than the old round one.

In the case of the gasfilled lamp, after the bulbs are exhausted of air, they are filled with the necessary inert gas, which may be either argon or nitrogen, according to the type of lamp; nitrogen is used only for heavy-current lamps. The argon used for the lower-current lamps is obtained by means of a liquid-air plant at the factory, the process being known as direct fractionation; this installation is extremely

Fig. 3.—Pump Room for Lamp Exhausting.

interesting, but too intricate to be described in the space at our disposal.

Automatic machinery, much of it specially designed on the premises and giving rapid and economical production, is a feature of the works, and the uninitiated visitor is invariably astounded at the way glass is "handled," so to speak, by mechanical devices. But even more wonderful is the process of blowing bulbs by machinery at the G.E.C. glass works at Lemington-on-Tyne. In this case there is no intervention of human hands between the red-hot molten glass and the completed bulb, and one attendant can supervise the production of thousands of bulbs in a day. Modern gas-fired furnaces, the temperature of which is controlled by electrical pyrometers, are installed (the works producing their own gas) and every appliance that tends to increased production and efficiency of manufacture has been adopted.

A notable addition to the equipment of the G.E.C. is the Research Laboratory at Hammersmith. Established within recent years, and under the able direction of Mr. Clifford C. Paterson, it concentrates upon researches that will give in the end new and improved processes of manufacture and higher efficiency in the finished product. The Lemington glass works are not overlooked in this important work; a resident chemist, on the staff of the Research Department, gives his whole time to the investigation and testing of the raw material used in the blowing of lamp-bulbs.

Extensions to the Osram lamp works on a large scale are in contemplation, some of which are on the verge of completion, with the aim of not only meeting the requirements of this country, but also filling the enormous overseas demand.

Following the inspection of the processes of electric lamp manufacture the visitors partook of an excellent luncheon at the Clarendon Restaurant, Hammersmith, Mr. C. Wilson in the chair, after which the members of the Institution settled down to a debate over which Mr. Norman Scorgie, borough engineer, Hackney, presided, on the subject of "Employment for the Unemployed."

LEGAL.

MINE MANAGER FINED.

W. DURNEY, certificated manager of Gain Clay Mine of the Glenboig Union Fireclay Co., was fined recently at Airdrie for three contraventions of the Mines Regulation Act of 1911. One of the charges was failing to see that the fireman he appointed devoted his whole time to the statutory duties, whereas he permitted him, while acting as fireman, also to work at a coal-cutting machine.

COST OF A CANTEEN.—PETITION OF RIGHT.

IN the King's Bench Division on March 18th, Mr. Justice Bailhache heard a petition of right brought by Messrs. J. P. Hall and Co., Ltd., electrical, &c., engineers, of Werneth, Oldham, asking for a declaration that they were entitled to reimbursement from the Crown in respect of the cost of building a canteen for their workers during the war. It appeared that Messrs. Hall became a controlled establishment, and were urged in common with others to provide canteen facilities. Sir John Simon, K.C., appearing for the suppliants, said they alleged that there came into existence a contract with the Crown to let them (suppliants) have the cost of making this canteen out of the Crown's share of profits. The Crown proposed to allow the company only £900 instead of the £1,500 which it contended it should have. Mr. Justice Bailhache, giving judgment, said he thought the expenditure upon the canteen was expenditure to be taken into account as current expenditure of the business, and taken into account before the net profits were arrived at. The Crown had so treated it, and he thought the Crown was right. The petition was therefore dismissed.

CATCHPOLE & MAURICE *v.* BARNETT.

BEFORE Mr. Justice Salter, in the King's Bench Division, on March 17th, plaintiffs, engineers, of New Oxford Street, London, sued Mr. B. Barnett, electrical engineer, of Whitechapel Road, to recover the balance of the price of goods sold.

Mr. SANDLANDS, for the plaintiffs, said the goods were delivered in January, 1920, and on other dates. He gathered that the only item now disputed was the one of £87 in respect of certain tubing supplied. The defendant, instead of complaining of the goods, asked for time to pay, and when the action had been brought, suggested that the tubing was not all it should have been. He never purported to reject it.

Mr. LINCOLN, for the defendant, said the tubing was not of the correct size, and the plaintiffs agreed to take it back. They did not, however, do so, and after several months the defendant used it, and was, of course, liable to pay. He (counsel), however, submitted that a new contract had really been made between the parties when the tubing was used, and that the defendant ought only to pay for it at the lower price which obtained then.

His LORDSHIP said the defendant had failed to satisfy him that there was any breach of warranty. There would, therefore, be judgment for the plaintiffs for the balance of the account, viz., £119 15s.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Dynamo Excitation.

With reference to your issue of March 18th, there appears on page 342 a paragraph headed "Extra Voltage for Battery Charging." This contains either an error or an omission.

Assume 100 volts normal.

Assume resistance of AE+CF=100 ohms.

Assume ampere-turns AE+CF=1,000 AT.

Then field current as shown=1.00 ampere. Again, taking imaginary values for AB and CD—

Assume AB+CD=140 ohms.

Then ampere-turns AB+CD=1,400 AT (with 1 ampere).

The voltage will not rise because the excitation current falls to 100/140 amperes=.715 amp., *i.e.*, ampere-turns remain as before for 1,400×.715=1,000 AT.

I have neglected any correction for variation in the mean length of the turn in the two portions of the field winding.

W. Hartley.

Calver.
March 19th, 1921.

[Our correspondent is perfectly correct. Neglecting temperature rise, and assuming that all the turns are of the same length, the ampere-turns at constant voltage depend only on the size of wire and are independent of the number of turns of wire, whether it be one turn or 1,000 turns. We have been caught napping!—EDS. ELEC. REV.]

Electrical Wiring Rules.

The point raised by "Bourgeois" in your columns, and answered by you, brings out the fact that there is no authority in England to compel contractors and others to install proper and safe electrical wiring. The remedy you suggest: "The registration of electrical contractors," to my mind, does not go far enough. An absolute cure would be the efficient and legally enforced inspection of all electrical work. This appears at first to be a somewhat tall order, yet it is done, and done well, in most of the large towns on the Pacific slope of the U.S.A. and Canada. In Vancouver, for instance, an electrical by-law exists, which incorporates a comprehensive set of local rules, and the National Electrical Code of the National Board of Fire Underwriters, and these rules are strictly enforced by the city electrician, assisted by a competent staff of inspectors. Any infringement is punishable by a fine not exceeding £20, at a magistrate's court. Before the wiring of any building can be started it is necessary to obtain a permit from the city electrician, and except on minor jobs, a complete wiring plan has to be submitted to him and passed, before a permit is granted. A blue print of each plan is filed for future reference. The cost of this scheme is largely met by the charge of a small fee for each light or motor, &c., installed, a sliding scale being arranged according to number. An additional fee is charged if reinspection is necessary, when the work fails to comply with the rules, and no installation is connected without a certificate from the city electrician. The city is divided into three "fire limits," and the class of building construction, sanitary work, and electrical wiring is graded according to the "fire limit" wherein the work is situated. The use of wooden casing for wiring has long been prohibited, and in the number one "fire limit," where most of the valuable and most modern buildings are located, the use of the screwed steel conduit system alone is permitted for all electrical wiring, this being the only system that comes up to the requirements of modern fireproof buildings. I consider that it is in the best interests of the electrical industry to standardise the quality of electrical installations throughout the country, and with this end in view, suggest that a National Electrical Code be formulated by a body similar in character to the National Fire Protection Association of America, on which are represented all branches of the electrical industry in conjunction with the fire insurance companies.

P. Davis.

Portsmouth.
March 19th, 1921.

An Electrostatic Phenomenon.

Has any fellow reader encountered the following interesting phenomenon? The other evening, when handling a 6-volt half-watt type motor headlight bulb, a strange bluish light was observed to flicker within the bulb, similar to a Geissler tube display. Doubtless this static discharge was induced by friction between the dry palm of the hand and the glass bulb, but it is noteworthy that the effect was at its maximum when the movement of the bulb was almost imperceptible, more vigorous rubbing having failed to accentuate the effect.

F. Cooper.

Wollaston.
March 21st, 1921.

The Direction of Rotation of A.C. Motors.

Would any reader explain how to tell the direction of rotation of a three-phase slip ring motor, before switching in?

Also what difference would it make in phase relation and running of motors if the direction of rotation of a three-phase alternator were reversed?

Inquirer.

March 17th, 1921.

Mr. Luckiesh and the Sheringham Daylight.

I hesitate to ask for your valuable space, but I feel it is necessary for me to clear up a misunderstanding pertaining to my artificial daylight units and the Sheringham unit. I refer to Mr. Sheringham's letter published in your issue of January 7th, 1921, p. 12.

I beg to call Mr. Sheringham's attention to the fact that I have not passed judgment on his invention, as he claims. If he will again refer to my letter to the *Electrical News*, Toronto, published in the issue of November 15th, 1920, he will find that I did not condemn his unit at all. I merely wished to call attention to the fact that his method had been tried by us long ago, and that we came to the conclusion, and still entertain the same opinion after eight years of practical experience with artificial daylight units that the principle of selective transmission is more practicable than the principle of selective reflection. There are less practical difficulties involved in making his unit, but the device is less desirable from a standpoint of permanency under all kinds of conditions.

I do not wish to start a discussion on this point, but merely to state my opinion that the glass filter will far outlast an unvitrified reflecting colour under severe conditions of application of such devices. I also wish to call Mr. Sheringham's attention to the fact that we made no claims as to originality

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of principle, for the principle was known as soon as Newton discovered the spectrum, and this applies to the principle which he has adopted. If Mr. Sheringham had been well-informed he would have known that I have discussed many of the developments of others along this line in various publications, and that in my "Colour and Its Applications," p. 227, I mention the unit produced by Dufton and Gardner, notwithstanding the fact that the descriptions I read of this unit show that the colouring was due to cobalt, and therefore was not a good approximation to daylight, for cobalt alone cannot accomplish such a result.

Furthermore, in the last paragraph of his letter he apparently attributes to me the statement that we have sold millions of colour-matching units. Again, if he had desired to be accurate he would have found in my original letter to the *Electrical News*, Toronto, that I made no such statement. Incidentally, I find on referring to the Electrical Review, December 24th, 1920, p. 819, that the Review was in error in quoting me.

To summarise, it appears to me that Mr. Sheringham has written either without being informed or has taken advantage of an error, which he should have known that I did not make, to upbraid me. I do not wish to start another discussion on this matter, but merely to clear up the misunderstanding for which the Electrical Review, and particularly Mr. Sheringham, are responsible. We wish Mr. Sheringham all the success possible with his unit, but we feel that it has been given more attention than it deserves, considering that for quite a number of years we have had on the market a more permanent device which has involved many difficulties in developing and producing that are not involved in producing a unit after the principle of selective reflection.

M. Luckiesh,
Director of Applied Science.

Nela Research Laboratory,
Cleveland.
February 25th, 1921.

[We regret that in our note of December 24th we inadvertently applied the word "millions" to the colour-matching devices of Mr. Luckiesh instead of "many thousands." The statement contained in his letter to the *Electrical News* is reproduced in full below:—

"For six or seven years we have had on the market our so-called artificial North Skylight colour-matching unit, our Noon Sunlight unit, and our Mazda C-2 (daylight) lamp which is a compromise between artificial daylight and luminous efficiency, and is merely a large step toward noon sunlight. We have many thousands of the first two units installed throughout the country, and since we placed these on the market, The Artificial Daylighting Co. has brought out colour-matching units, and I understand has sold a great many of them. Our Mazda C-2 (daylight) lamp which meets the requirements in a great many cases gives a light approximating average daylight in quality, and is of sufficient luminous intensity to be used for general lighting purposes. These have already been sold to such an extent that millions of them have been manufactured and installed."

It will be seen that the word "millions" applies only to the "daylight lamp." We gather from Mr. Sheringham's letter that he was aware of this, as he refers to "lamps that do not attempt to reproduce north sky light," and we feel that he cannot be held responsible for the misunderstanding. Our interpretation of Mr. Luckiesh's original letter to our contemporary is that it virtually condemns by implication the Sheringham daylight reflectors in the following passage:—

"I do not wish to discuss the merits of this particular unit more than to state that I tried this method out about eight years ago and abandoned it in favour of the straight-forward method of modifying the light by selective transmission."

—Eds. Elec. Rev.]

Wiring in Ferro-concrete Factories.

I am astonished at the tone of the letter written on behalf of the St. Helens Cable & Rubber Co., Ltd., and published in your issue of the 18th inst., and venture to say that it is not one calculated to increase confidence.

The remarks of "Inquirer" appear to be perfectly fair comment, and probably he was considering protection from fire rather than electrical or mechanical protection.

I cannot see any necessity for proving such a conjecture in that case, and to insinuate that such a statement is libellous is absurd.

With regard to the question of name and address, I know it is your invariable practice not to publish letters without receiving these, and doubtless "Inquirer" would have no objection to disclosing them to the firm.

The opening of your columns (of which there have been recent examples) to the discussion of the merits or otherwise of trade products, though attended with some risk of unpleasantness, seems to me to be of great value to all concerned, whether as makers or consumers.

But it is necessary that such discussion should be carried on fairly and courteously on all sides, when I am sure, the manufacturer will benefit as much as anybody.

With regard to the merits of C.T.S., although I have seen a fair amount of this used during the war, I have not had a long enough experience with it to be able to comment upon it, but should be very interested to hear from any of your readers who may care to relate their experiences as to its lasting properties, its suitability or otherwise for laying underground, for use outside exposed to sunlight and weather, and so forth.

A. C. Purday.

Croydon.
March 19th, 1921.

The Cost of Living in China.

Knowing that you like to publish periodically the experience of engineers abroad, perhaps the following up-to-date figures on the cost of living in Shanghai will be of interest to those who contemplate coming out here. Although these figures are my actual costs, they truly represent the average for a man and his wife with no children, in a small house. The total expenses can be reduced by about 15 per cent. by living in a boarding house, but this should be avoided if possible, as it is far from comfortable.

A young bachelor can live on about 350 taels a month if he stays at a boarding house or shares a house with two or three others, but should not accept less than 400 taels unless the firm assists him with a house allowance or provident fund.

I have given detailed costs so that items may be added or cut out to suit the taste of the individual, but very few men out here will admit that any of them can be cut out, and most will think they are too moderate.

An engineer should not be misled by the value of the tael or dollar, as this affects nothing but his savings, and these only if he intends to convert them into sterling.

	Taels per month.
Rent of unfurnished house, 4 or 5 rooms ...	85.00
House tax, 14 per cent.	11.90
Furniture (16 per cent. p.a. on cost) or hired	40.00
Servants	35.00
Electric light and water	9.50
Groceries, provisions, &c.	69.00
Coal (and ice in summer)	21.00
Laundry	9.00
Wines and spirits	8.60
Amusements	19.00
Cars, rickishas and tramcars	18.00
Clothing	58.00
Medical attendance (for wife)	7.00
Club subscriptions and chits	18.00
Papers, tobacco, &c.	7.00
Life insurance, £1,000 at 4.5 per cent. ...	45.00
Savings (20 per cent. of salary)	115.00
Total	576.00

The exchange between taels and dollars does not vary much from 72 taels equals 100 dollars, so a salary in dollars should not be less than 800 per month for the first year.

The above figures are the averages for the last 12 months, during which, strenuous efforts have been made to reduce every item except the last.

This item "savings" is almost invariably lost sight of by employers when fixing salaries, and unless the firm in question runs a generous provident fund it is absolutely necessary to save at least a fifth of one's income to pay for the wife's passage home and out every three or four years, and other necessary holidays and contingencies.

Six Years in the East.

Shanghai.
February 11th, 1921.

[We are grateful for this excellent statement, which will be of great value to many of our readers. By affording such information our correspondent has rendered a public service. Similar statements from other parts of China, East, West, and South Africa, Burmah, &c., would be welcomed.—Eds. Elec. Rev.]

Large Mercury Arc Rectifiers.

At the informal meeting of the I.E.E. on the 14th inst., some questions were asked as to maintenance of rectifiers. Reference to such plants will be found in the following publications:—

Elect. Tech. Zeit.				*Science Abstracts.*		
Vol.	Page.	Year.		Vol.	Page.	Year.
33	1164	1912	...	16B	82	1913
34	253	1913	...			
34	1415	1913	...	17B	93	1914
34	1479	1913	...	17B	94	1914
38	88	1917	...	20B	247	1917
39	321	1918	...	21B	410	1918
39	414	1918	...	22B	36	1919

Electrician, Vol. 82, 589, 1919.
Elec. Rly. Journal, Vol. 44, 1343, 1915.
Elec. World, Vol. 60, 1157, 1912, and Vol. 62, 548, 1913.
Elec. Review, Vol. 84, 191, 1919, Vol. 88, 217 and 251, 1921.

Alec. B. Eason.

London.
March 14th, 1921.

Power Installations.

The popularity of the electric drive is such a marked feature nowadays on account of its convenience, low cost, and adaptability to all classes of machinery that the exact calculation of the correct size of motor for each operation becomes a matter of importance, more particularly in connection with alternating-current systems where the question of power factor arises in its relation to the loading of the motors. I have so far failed to discover a text-book or hand-book which gives formulæ covering the calculation of horse-power applicable to drilling, planing and stamping machines, also printing presses, operated either by group or individual drive, and should feel grateful if any of your readers could furnish me with the title of such a book or books, giving also names and addresses of the publishers.

I incline to the opinion that in many instances the low power factor obtainable on power installations is due in some measure to the guess-work methods employed in deciding the size of motor suitable for the job.

Interested.

Lead-covered Wiring.

I have carefully considered your reply to my inquiry, for which I thank you, and the subsequent communication from "Engineer Contractor."

My point is as follows:—A large firm of electrical contractors, who are supposed to be first-class engineers—not glorified plumbers or ironmongers, mark you—wired up three lights for me. I had occasion recently to take up a floor board under which their wires ran. The spaces between the joists were full of chips and wood shavings. What did I find? A perfectly fitted conduit system? No, Sir. Bare wires everywhere except where they dived through the ceiling; then the conduit system commenced.

Now, I ask you, what is your Contractors' Association going to do to prevent this sort of thing? *And this firm belongs to the Contractors' Association.* The stamp is on their notepaper.

Bourgeois.

[It is not always possible to *prevent* bad work, but it can be remedied. The proper course for "Bourgeois," we take it, is to give the particulars and the name of the contractor to the Association, which will no doubt take up the matter.

With regard to the merits of the case, whether it was a serious neglect of duty or not depends upon the circumstances. The use of unprotected wires (not, of course, literally *bare*) under floors is not necessarily blameworthy.—Eds. Elec. Rev.]

Your correspondent "Bourgeois" does not directly make a charge against lead-covered wiring, but he makes an insinuation which it would probably be difficult for him to substantiate. It is unfair and unreasonable for anyone to write to the technical Press that he "has understood that the above-mentioned system is condemned." By whom is it condemned, and for what reason? I have had a lot of experience of such systems, but I have never heard of the condemnation. Little innuendoes have a habit of growing into big canards, and people who jump into print should be careful what they write.

Talk about "fires caused by an electric fuse" will never cease during the lifetime of anyone at present on this earth. That is because all people who have an electrical installation, and all people who write for the lay Press, never will all be electrical engineers.

I cannot understand electrical people giving further publicity to this libel against electricity. Fires are always due to maliciousness or carelessness. The *method* of providing the light is never the cause, but some human failure in the proper use of the method. Candle, oil, and gas lighting are probably *each* responsible for very many more hundreds of fires than electricity. Indeed, electricity is the safest method, providing least opportunity for the intervention of the defective human element. And a good lead-covered or metal-covered system, if it is properly installed by an efficient wireman under conditions laid down in the I.E.E. rules—as *all* systems should be—is just as safe as any other method of electrical installation. I, personally, know of several hundred installations on the Henley wiring system—a metal-covered system—which have been in use many years, and I have never heard of one single case of fire in any of them.

Othello.

London.
March 19th, 1921.

[Several letters have unavoidably been held over.—Eds. Elec. Rev.]

BUSINESS NOTES.

Bankruptcy Proceedings.—John Vincent Bell, 21, North Bar Within, Beverley, East Riding, Yorkshire, electrical engineer.—The public examination of this debtor was fixed to be held on March 14th, at the Guildhall, Hull, but the investigation which was being made into the debtor's affairs was not complete, and the examination was adjourned.

John Jones and John Richard Jones, trading as J. Jones and Son, 7, Chapel Street, Penzance, Cornwall, electrical engineers.—The first meeting of the creditors of the above was held recently at the Official Receiver's Office, Truro. According to the statement of affairs, the liabilities amounted to £1,078, against assets £776. Debtors attributed their position to serious illness of the senior partner, his wife, and daughter, pressure of creditors, and depreciation of the value of stock. It was stated that they commenced business two years ago, but were not aware of the amount of capital they then possessed. The only books of account kept were a day-book and a ledger, and there were no accounts of receipts and payments. They became aware of their position a month before the receiving order was made. The separate estate of John Jones showed a surplus of £151, while that of John Richard Jones showed assets £10, and no liabilities. It was decided that Mr. W. C. Pezzack, accountant, of Penzance, should be appointed trustee of the estate, assisted by a committee of four of the creditors.

E. A. Goodings (Goodings & Son), motor and electrical engineer, The Grove, Watlington Street, Reading.—First meeting March 24th, at 14, Bedford Row, W.C.; public examination, April 21st, at the Assize Courts, Reading.

W. Drysdale, electrician, 24, Paxton Street, Barrow-in-Furness.—Last day for proofs for dividend, March 31st. Trustee, Mr. H. Mossop, 4, Ramsden Square, Barrow-in-Furness.

G. F. Kiveron, electrical engineer, Sheffield.—First and final dividend of 3s. 10½d. in the £, payable at the Official Receiver's offices, Sheffield, on March 22nd.

Company Liquidations.—Fluorundum Flame Carbons, Ltd.—Winding up voluntarily. Liquidator, Mr. F. N. Clarke, 4, Pavilion Buildings, Brighton. A meeting of creditors was called for March 22nd.

Mersey Electrical Engineering Co., Ltd.—Winding up voluntarily. Liquidator, Mr. T. L. Hanmer, 24, North John Street, Liverpool.—A meeting of creditors is called for March 29th, at Liverpool. Particulars of claims should be sent to the liquidator by April 15th.

Bastian Electric Co., Ltd.—A petition for winding up has been presented to the High Court by Mr. W. F. N. May, of Bedruthen, Barnt Green, Worcester, and Mr. A. E. Wall, of Baddesley House, Hatch End, Middlesex, and will be heard in London on April 12th.

Grimsby Electric Welding Co., Ltd.—Winding up voluntarily. Liquidator, Mr. H. Blanchard, Humber Bank, Fish Docks, Grimsby.

Portable Electric Motors, Ltd.—A petition for winding up has been presented to the High Court by Messrs. Electric Tools and Motors, Ltd., of 31-33, High Holborn, W.C., and will be heard in London on April 12th.

Dissolutions of Partnership.—Tierney, Wood & Co., electrical engineers, 484 Oldham Road, Failsworth, Manchester.—Messrs. F. S. Ormerod, J. Tierney, and J. Wood have dissolved partnership. Mr. J. Tierney and Mr. J. Wood will attend to debts and continue the business.

Ryeland & Ferguson, electrical engineers and contractors, 44, Weston Street, London Bridge, S.E.—Mr. W. L. Ferguson and Mr. A. E. Ryeland have dissolved partnership. Mr. A. E. Ryeland will attend to debts and continue the business.

Trade Announcements.—Messrs. J. B. Saunders & Co., Ltd., announce that on the expiration of the lease of their temporary offices they have returned to Westminster, and their address is now 11, Dacre Street, Westminster, S.W. 1.

Mr Alfred White has removed from Empire Buildings to 4, Norfolk Street, Sunderland.

The Cambridge and Paul Instrument Co., Ltd., of 45, Grosvenor Place, London, S.W. 1, has now opened two repair depôts. For the convenience of customers in Scotland and the North, a depôt has been established at 12, Westgate Road, Newcastle-on-Tyne, and for customers in the Midlands a depôt at Empire House, Great Charles Street, Birmingham.

Mr. S. P. Marsh, electrical engineer, of 63, Regent Street, Rugby, has disposed of his business to Mr. F. Pritchard, A.M.I.E.E., A.M.I.Mech.E., with whom he will, however, continue for some months.

Mr. A. W. Coward, of Mill Lane, Chadwell Heath, Essex, has entered into partnership with Mr. C. B Maurice, of "Berwick House," 139, Oxford Street, W., who will now trade under the name of Messrs. Maurice & Coward, at the same address. Telephone, "Museum 3627."

The General Electric Co., Ltd., announces that, as from April 4th, its registered office will be Magnet House, Kingsway, London, W.C. 2.

German Cable Industry.—The electric cable industry of Germany had a bad year during 1920. The goods sold abroad during the first six months did not total as much as 30 per cent. of the pre-war figure, says the *Engineer*, and during the last half-year they fell below 25 per cent. Sales in Germany ceased altogether.

Inquiry.—The name and address of the makers of "Seecol" dimmers are asked for. Also makers of a lamp-testing wattmeter.

Catalogues and Lists. — Messrs. A. Gallenkamp and Co., Ltd., 19-21, Sun Street, Finsbury Square, E.C. 2.—Catalogue No. 75, illustrating and describing a number of electric furnaces for temperatures up to 1,000° C. These are of the tube, muffle, and crucible types. Also Circular No. 207, which describes a furnace for carrying out the Leeming coking test of coal. Both publications are fully priced.

Simplex Conduits, Ltd., Garrison Lane, Birmingham.—A beautifully-produced catalogue of "Simplex" lighting fixtures of many types. The illustrations show bowl fittings, brackets, pendants, hall lanterns, table lamps, switch plates, electric signs, &c. A price-list is included in the booklet.

Messrs. W. T. Henley's Telegraph Works Co., Ltd., Engineering Department, Blomfield Street, London Wall, E.C. 2.—List U E 5, giving illustrations, prices, and full details of terminal boxes for outdoor work. The types shown include boxes for two, three, and four-core cables for voltages ranging from 660 to 20,000. Details of glands and jointing instructions are also given.

Messrs. L. G. Hawkins & Co., 116, Charing Cross Road, W.C. 2.—A poster announcing a special "spring offer" of "Universal" domestic electrical appliances. Also an illustrated folder, "Domestic Service Electrified," dealing with the same subject.

Huntalite, Ltd., 25, Newman Street, W. 1.—A folder giving illustrations and prices of floor and table standards, in antique walnut, for electric lighting.

Westinghouse Electric International Co., East Pittsburg, Pa., U.S.A.—An illustrated catalogue of electric toasters, radiators, irons, cookers, &c.

Messrs. Watson & Sons (Electro-Medical), Ltd., Sunic House, 43, Parker Street, W.C. 2.—"Sunic Record" No. 13, giving some useful notes on radiographic work and curves plotted from results obtained with the firm's spark gaps, giving pressures in kilovolts for various gaps; Bulletin 32 S, a price-list of duplitised X-ray films and dental films and accessories; also Folder 33 S, dealing with the improved "Sunic" X-ray plate.

The General Electric Co., Ltd., 61, Queen Victoria Street, E.C. 4.—Leaflet O.S. 2,465, advertising the "Kingsway" miners' hand lamp, and giving illustrations and prices of screwed and bayonet cap lamps for use with this.

Also an illustrated catalogue giving particulars and reduced prices of "Osram G.E.C." vacuum and gasfilled electric lamps. The list includes views of the lamp works.

The Imperial Engineering Co., 61, Darlington Street, Wolverhampton.—An illustrated and priced leaflet, advertising the "Imperial" 440-watt electric toaster, with flex and adapter.

Messrs. Fraser & Glass, Assembly Works, Middle Lane, Hornsey, N. 8.—Two illustrated leaflets (Lists Nos. 1 and 2) showing examples of steel chains for balancing and driving.

The Electrical Apparatus Co., Ltd., Vauxhall Works, South Lambeth Road, S.W. 8.—Leaflet H 41/3, a well-illustrated price-list of ironclad switches, draw-out pillars, and switchboards, giving full details and specifications.

Metropolitan-Vickers Electrical Co., Ltd., 20, Brazennose Street, Manchester.—Leaflet No. 379/1—1, giving descriptions and details of three-phase transformers for rotary converters; No. 379/1—3, illustrations of three-phase transformers for rotary converters; and No. 711/1 A, illustrating and describing transformers for use in collieries.

Messrs. Meldrums, Ltd., Timperley, near Manchester.—Two leaflets illustrated in colour—one showing the "Meldrum" forced-draught furnace applied to a Lancashire boiler, and the other depicting the "Meldrum" mechanical stoker with moving grate and forced draught.

Pope's Electric Lamp Co., Ltd., Elasta House, 5, Arthur Street, W.C. 2.—Leaflet C.L. 1, illustrating and describing "Elastalite" 20-watt candle lamps. Fully priced.

The Edison Swan Electric Co., Ltd., Ponders End, Middlesex. List No. PP 213, an illustrated catalogue giving very full particulars, and also prices, of petrol-electric lighting and pumping sets of capacities ranging from 3 to 13 kW. Batteries and switchboards are also illustrated and described.

Hart Accumulator Co., Ltd., Marshgate Lane, Stratford, E.C. 15. Catalogue for 1921. The list gives illustrations of all types of accumulators (with prices), and each section is indicated on a thumb index for easy reference; it is bound in stiff covers.

For Sale.—The Lancashire and Yorkshire Railway Co. has for disposal one Yates and Thom compound vertical engine, direct-coupled to a 750-kW Dick, Kerr generator.

Wigan Corporation Electricity Department has for sale a Thompson patent straight water-tube boiler (vertical type).

Elland Urban District Council, consequent on purchasing electrical energy in bulk, has for disposal the contents of its electricity station.

Messrs. Eadon & Lockwood will sell by auction, on April 19th and following days, at Chilwell, Notts., electrical plant, machinery, &c.

By direction of the Disposal Board, Messrs. Fuller, Horsey, Sons and Cassell will sell by auction, on April 20th, at Greenwich, surplus electrical plant, including a 1½-kW wireless transmitting and receiving set, generating sets, &c. For full particulars see our advertisement pages to-day.

Social Events.—The annual dinner of the Torquay Electricity Supply Department took place at the Royal Hotel, on March 12th, Mr. H. F. G. Woods, the borough electrical engineer and manager, presiding. A musical evening followed, the programme being provided by various members of the staff.

A dinner was held at the Connaught Rooms, on March 8th, at which the executive, management, and depôt superintendents of the Edison Swan Electric Co., Ltd., were present. The chair was taken by Mr. C. Jermyn Ford, the chairman of the company, supported by Major Eustace Quilter and Mr. E. A. Gimingham, directors, and amongst the visitors were Messrs. R. C. Lanphier and S. B. Rogers, the former being the vice-president of the Sangamo Electric Co., U.S.A., whilst the latter is the European manager of the Sangamo Co., a concern closely associated with the Edison Swan Electric Co., Ltd., who are the sole Sangamo agents for Great Britain and the Colonies. During the evening the toast of "The Chairman" was proposed by the commercial manager, Mr. C. Horace Cox. "The Depôt Superintendents" was proposed by Mr. J. W. Elliott, joint sales manager, and this was replied to by Mr. J. Taylor (Glasgow), and Mr. A. McDonald (Dublin). "The Visitors," proposed by Mr. E. A. Gimingham, was responded to by both Mr. Lanphier and Mr. Rogers. A musical programme was provided by the Misses Violet Holt and Barbara Laughton, Messrs. George Tinney, A. P. Ambler and E. H. Miller; the last of these sang an Ediswan Topical Song.

How American Merchants are Cutting Down Expenses.—Valuable information as to how merchants of the country are cutting down their expenses to meet the present slump in business is being received by the Domestic Distribution Department of the Chamber of Commerce of the United States. More than 15,000 letters of inquiry were sent out to wholesalers, jobbers, commission merchants, and retailers, asking them certain questions regarding their present overhead expenses, and what they are doing to reduce them. Already a multitude of replies has been received at the headquarters of the National Chamber, and in almost every case the merchant is reducing his operating expenses so that he can meet the pressure of the public for lower prices. Most of the answers report that workmen are more efficient than they were this time last year, when there was plenty of work to be had. Some firms have eliminated pay for overtime, while others have reduced salaries. "We are weeding out the drones and keeping our efficient workmen," is a typical statement. In this connection one man stated that he had cut down his force 44 per cent., and that his production had increased 25 per cent. Originally, he employed 25 men. When the first depression in business affected him, he cut down his force to 22, and his output remained the same. He reduced his force a second time to 14 men, and his production went up 25 per cent. At the same time, he reported a wage reduction of 30 per cent. Some firms replied that they were not reducing the wages of their old employés, but that they were hiring new men for less money. Others said they would not reduce wages until the cost of living dropped appreciably. "We are reducing the amount of our bonuses by 50 per cent., and we are cutting down our commissions on sales," is quite a common reply. This is the way in which one merchant explained the manner in which he handled his wage problem when the present business depression set in:—"We called our men together, and laid our cards on the table. We had nothing to withhold. We told them that we could not continue to do business with the present wage scale unless they became more efficient. By increasing their efficiency they made it possible for us to reduce our prices." Everywhere the replies indicate that there is a tightening of credit, without any general reduction of volume. New accounts are being more closely scrutinised, and bills are reaching the hands of collectors a little sooner than when business was brisk. The replies are about evenly divided on the question—"Have you reduced your advertising space?" A number of merchants report a reduction, while some say they are more careful in their advertising. A large number of merchants report that they have increased their advertising appropriations. They point out that advertising is a means of sales promotion, which should be pushed at this time especially. These answers are being collected in digest form by the National Chamber for the purpose of disseminating this information to business men.—*Reuter's Trade Service* (Washington, March 7th).

Water Power in Peru.—The Commercial Secretary to H.M. Legation at Lima (Mr. F. W. Manners) has forwarded to the Department of Overseas Trade a translation of a projected Bill recently presented by the Finance Minister to the Peruvian Congress concerning the nationalisation of water power in the Republic of Peru. Under this Bill all water-power concessions will be granted under the provisions of the Mining Code by the authorities therein appointed. The translation may be seen by United Kingdom firms interested at the Inquiry Room of the Department of Overseas Trade, 35, Old Queen Street, London, S.W. 1.

German Companies' Working Agreement.—At a general meeting of the Allgemeine Elektricitäts-Gesellschaft, the president Herr Rathenau, proposed a scheme of closer union with the Linke-Hoffmann works, and an increase of capital.

On the side of the A.E.G. the object of union is, briefly, to avoid contraction of the activities of their vast repair sheds in favour of new construction, by attaching themselves to a locomotive concern which disposes also of important partly-finished articles of manufacture. On the other side, the Linke-Hoffmann works are anxious for the union, because they foresee that the electric-locomotive business will gradually increase in importance, and needs for this purpose close connection with a large electrical concern.—*The Times.*

Unemployment Benefit Figures.—Some very instructive figures regarding the cost to the State of maintaining the unemployed are given in a written answer by Mr. Macnamara to Sir W. de Frece. From January 1st to March 11th there was paid out in unemployment benefit £5,300,000, and in out-of-work donation £2,900,000. Since November grants for roads to the extent of £3,000,000 have been paid. An equal sum has been paid by way of loan. The Unemployment Grants Committee has sanctioned £764,545 since January 1st. Productive work has been found for about 100,000 men.—*Morning Post.*

To Finish in Germany.—It is announced in the Finnish Press that arrangements are being made to send some 10 young engineering students, who have comp'eted their course in the Technical High School at Helsingfors, to Germany, in order that they may make themselves familiar with the latest developments in the big industrial establishments of that country. Each student is to stay about a year in Germany, and the firms of Siemens and Halske and Voigt's turbine factory are mentioned as those to which the students will be attached. A sum of 100,000 marks is provided in the budget for defraying the initial expenses of the scheme.

Book Notices.—"The Metropolitan-Vickers Gazette." Vol. VI, No. 95. February, 1921. (23 pp.).—This issue contains the usual interesting well-illustrated articles, including "Electrical Equipment of Oil Wells," "Works Testing Devices," and a description of a new workmen's canteen at the Trafford Park Works.

"*Journal* of the Institution of Electrical Engineers." Vol. LXIX, No. 397. January, 1921. London: E. & F. N. Spon. Price 10s. 6d.—This issue contains the following papers:—"The Distribution of Electricity," by Mr. W. B. Woodhouse; "Some Economic Aspects of e.h.p. Distribution by Underground Cable," by Mr. R. O. Kapp; the Twelfth Kelvin Lecture "Electrons," by Sir W. Bragg, F.R.S.; "A Precise Form of the Kelvin Electrostatic Voltmeter," by Mr. E. H. Rayner; "The Whitened Cube as a Precision Integrating Photometer," by Mr. H. Buckley; and "Range of Wireless Stations," by Captain R. C. Trench.

Scientific Paper No. 408 of the U.S. Bureau of Standards, "Effect of the Rate of Cooling on the Magnetic and other Properties of an Annealed Eutectoid Carbon Steel" (14 pp.). Washington: Government Printing Office. Price 5 cents.—This is a record of experiments carried out on six specimens of steel which were heated to 800° C., and allowed to cool at various rates. The following properties were then measured:—Normal induction for ordinary and large magnetising forces, residual induction, coercive force, resistivity and Shore scleroscope hardness.

Fuel Research Board. Technical Paper, No. 1. "The Assay of Coal for Carbonisation Purposes: a New Laboratory Method." By Thomas Gray, D.Sc., Ph.D., and James D. King, F.I.C., A.R.T.C. London: H.M. Stationery Office. Price 6d. (by post 7d.).—The Fuel Research Board has begun the issue of a series of special papers and reports which will be known as Technical Papers of the Fuel Research Board. These papers will be prepared from time to time on the results of the work carried out at H.M. fuel research station or elsewhere, and will, it is thought, be valuable to all who are concerned with fuel problems. The present report, the first of the series, describes the development of a method of coal assay in which by direct weighing and measurement the yields of gas, oil, water and carbonaceous residue resulting from the carbonisation of coal at different temperatures can be quickly and accurately determined. The experimental results given in the paper show that the method supplies valuable information which cannot be obtained directly from the ordinary laboratory methods hitherto used in the testing of coal. Tables and graphs illustrating the experimental work are incorporated in the report.

"Engineering as a Career." By Percival Marshall, A.Inst.M.E., and Alfred W. Marshall, M.Inst.M.E., A.M.I.E.E. (56 pp.) London: Percival Marshall & Co. Price 9d. net.—This is the second edition of a very useful little guide for those seeking an entrance to the engineering professions. Mechanical engineering is dealt with at a greater length than other branches, as the authors state that "it offers the largest field for employment, and is really the basis of nearly all engineering work." A list of the principal engineering colleges and technical schools is included.

British Standard Specification, No. 91—1921, "Electric Cable Soldering Sockets" (for cables from 0·0018 to 1·000 sq. in. sectional area). London: Crosby Lockwood & Son (for the B.E.S.A.). Price 1s. net. This specification includes definitions and clauses relating to the material and dimensions of cast and wrought lug sockets, clamp sockets and their clamps. Attention is directed to the care which should be taken to ensure that the cable fits the hole in the socket, so that the current will not have to traverse an undue amount of solder.

Also No. 139—1921. "Red Fir Wood Poles for Telegraph and Telephone Lines." Price 1s. net. This specification deals with light, medium and stout poles of lengths varying from 16 to 85 ft. A section dealing with creosoting is included.

"Welfare Work." Vol. II, No. 15. March, 1921.—This issue gives details of a workmen's compensation scheme in force at the Bournville works of Messrs. Cadbury Bros., and articles on "Progress in China," and "The Science of Industrial Management."

"Science Abstracts A and B," Vol. XXIV, part 2, February 28th, 1921, also index to Vol. XXIII (A and B). London: E. and F. N. Spon, Ltd. Price 2s. 6d. each net.

"Radiographic Technique." By T. Thorne Baker. Pp. xii + 196. 62 figs. London: Constable & Co. Price 15s.

"Electrical Installation Work (including Electric Wiremen's Work)." By J. H. Havelock. Pp. viii + 366; figs. 120. London: Crosby Lockwood & Son. Price 15s. net.

"Lehrgang der Schaltungsschemata Elektrischer Starkstrom-Anlagen." By Prof. J. Teichmüller. Munich: R. Oldenbourg. Price 68 marks.

"Year-Book of Wireless Telegraphy and Telephony for 1921." London: Wireless Press, Ltd. Price 21s.

"Opportunities in Engineering." By C. M. Horton. Pp. 90. London: University of London Press, Ltd. Price 3s. 6d. net.

"Freileitungsbau Ortsnetzbau." By F. Kapper. Munich: R. Oldenbourg. Price 65 marks.

Demand for Machinery in India.—Machinery for brass and iron foundry work, and for sanitary, mechanical, and electrical engineering, is in great demand.—*Reuter's Trade Service* (Bombay).

A Standard Customs Declaration Form.—The question of a standard Customs declaration form for use throughout the British Empire, which was fully considered by the Federation of British Industries in 1918, has again been brought into prominence by the deliberations of the Empire Customs Conference.

The Executive Committee at its meeting on March 9th sanctioned the appointment of a Committee of representatives of the industries most likely to be affected to consider further action on the part of the Federation. The Committee consists of representatives of the B.E.A.M.A., the National Federation of Iron and Steel Manufacturers, the British Engineers' Association, the Association of British Motor and Allied Manufacturers, the Wall Paper Manufacturers' Association, and Messrs. Lennox B. Lee, A. K. Davies, E. R. Firth, George Garnett, W. V. Collier, Harry Allcock, Thomas Bolton, L. J. E. Hooper, P. H. Lockhart, E. H. Matthew, Frank Moore, R. M. Bewick, A. E. Jacob, W. B. Pickering, F. B. Nathan, and R. A. Pilkington.

On the recommendation of this Committee a letter has now been addressed to the Comptroller-General, Department of Overseas Trade, drawing attention to the careful consideration devoted by the Federation to the question of evolving a standard Certificate of Origin and Value, and suggesting the desirability of a joint meeting between representatives of the Conference and the Federation, to discuss both this point and other questions of importance to Industry, such as treatment of commercial travellers, samples, &c., which it is understood the Conference proposes to investigate. A draft form of standard certificate approved by the Committee was submitted together with the letter.—F.B.I. *Bulletin.*

Electricity and Paper-making.—A correspondent of *The Times Trade Supplement* says electrical engineers have been considering the large scope for enterprise that is presented to them owing to what they regard as the backwardness of our paper-making interests in the use of electricity. Statistical information prepared by the paper-makers' organisation is quoted to show that out of 500 paper-making equipments in the United Kingdom, only 21 have adopted electrification. As the British paper-making industry in some sections is faced with the necessity for less conservatism in its attitude toward modernisation as a means for securing efficiency and economy, it is not surprising that electrical installation engineers and manufacturers are looking in this direction for a fair amount of work before long.

Standardisation of Government and Municipal Contracts.—The Executive Committee of the Federation of British Industries, at its meeting on March 9th, considered a recommendation from the De-Controlled Associations Committee that a Committee, representative of all important industries affected, should be set up to investigate the possibility of securing the adoption of a standard type of Government and municipal contract and form of tender; and to inquire and report as to whether any conditions were imposed (including special conditions referring to particular goods), which were unnecessarily onerous, and, consequently, detrimental to the advancement of trade.

It was moved by Sir John Mansell, and unanimously resolved, that the recommendation be adopted, and that representatives of the following industries be asked to serve on the Committee of Inquiry:—Electrical engineers, general engineers, machine tool trades, tube manufacturers, wire rope makers, tanners, brush manufacturers, cable makers, iron and steel manufacturers, cement manufacturers, paper makers, shipbuilders, woollen and worsted trades, builders, aircraft manufacturers, master printers, boot makers, motor manufacturers, wagon builders, explosives trade, food manufacturers, oil and fat producers, and two representatives of the de-controlled associations.

The Committee was empowered to approach directly, and to hold meetings or interviews with, representatives of any Government department and municipalities, particularly the Admiralty, the War Office, the Air Board, the India Office, the Crown Agents for the Colonies, and the Ministries of Transport, Health, and Labour. —F.B.I. *Bulletin.*

Trade with Russia.—The Board of Trade (Licensing Section) announces that licences are no longer required for the export to Russia of any goods other than goods, the export of which is prohibited except under licence to all foreign countries.

Spanish Commercial Treaties.—The Spanish Government has decided to extend the commercial treaties lapsing on 20th inst. until the new Customs tariff comes into effect.—*Reuter's Trade Service* (Madrid).

Patent Application.—Ravul Frère has applied for restoration of Patent 23,018, of 1913, for "Improvements in means for automatically controlling the supply of air to boiler furnaces."

A New Norwegian Electrical Association.—The Department of Overseas Trade is informed by the Commercial Secretary to H.M. Legation at Christiania that at a meeting recently held in Christiania by Norwegian factories and workshops capitalised with Norwegian money for the purpose of producing Norwegian electro-technical products, it was decided to form the National Association of Electro-Technical Industries (Landsforening vor Electro-teknisk Industri) with the object of protecting the common interests of its members and of working to consolidate the position of the electro-technical industry.

LIGHTING AND POWER NOTES.

Aberdare.—Year's Working.—The accounts of the electricity department for the year ended March 31st, 1920, show a total revenue of £11,089, as compared with £8,204 in the previous period. Working costs amounted to £6,927, as against £5,020, leaving a gross profit of £4,162 (£3,184). The net result was a profit of £570, comparing favourably with a deficit of £92 in the previous year. The number of units sold increased from 1,208,960 to 1,374,254. An interesting item in the revenue account of the destructor department is the sale of steam to the value of £1,285 to the electricity department.

Aberdeen.—Proposed Extensions.—At a meeting of the Electricity Committee a scheme for extending the electricity works, at a cost of £210,000, was considered, and it was decided to place the scheme before the Electricity Commissioners.

Arbroath.—Proposed Price Increase.—The Arbroath Electric Light and Power Co., Ltd., has applied to the Ministry of Transport for an order under the Electric Lighting Act (1899) to modify the existing statutory powers under the Arbroath Electric Lighting Order. The Ministry has been asked to approve of an increase in the present rates.

Belper and District.—Extension of Supply.—The Derbyshire and Nottinghamshire Electric Power Co. is applying to the Electricity Commissioners for powers to generate and supply electricity within the urban districts of Belper and Heage.

Burton-on-Trent.—Extensions.—The Town Council has approved the recommendations of the Electricity Committee with regard to plant extensions. It is proposed to purchase some second-hand plant from the Nottingham Corporation at a cost of £10,500; this with the necessary auxiliaries and arrangements for erection is estimated to cost about £33,500.

Camberley.—Electricity Supply.—The Yorktown and Blackwater Gas Co. has completed negotiations with the War Office for a supply of electricity in bulk from the power station at Aldershot; it proposes to supply electricity for lighting at 8d. per unit, and for power at from 4½d. to 5d.

Carmarthen.—Price Increase Deferred.—The Carmarthen Electric Light Co. recently applied to the Corporation for an 80 per cent. increase in the public lighting charge, and a sub-committee of the Corporation, having heard a deputation from the company, recommended an increase of 50 per cent. At a Council meeting the matter was referred back for further consideration, the proposer alleging that the recommendation was carried by the votes of members who were shareholders of the company.

Chichester.—Proposed Purchase of Undertaking.—At a recent meeting of the City Council, the Mayor stated he had received a letter from the Electric Light Co. offering its undertaking to the Council at a price to be agreed upon by arbitration, or as an alternative the Council could make an offer to the company. A Sub-Committee appointed to deal with the matter, recommends that the Council offer the sum of £12,500, subject to the settlement of all outstanding claims upon the undertaking. It is also recommended that sanction be sought to a loan of £14,500 to cover the purchase price and the cost of putting some of the plant into proper working order.

Continental.—Switzerland.—Owing to the protracted drought, hydro-electric undertakings have been unable to keep up their output; this is having a detrimental effect upon the railways, agriculture and other industries which are now dependent upon an adequate supply of electricity. Rain has fallen this week.

Czecho-Slovakia.—Activity is being displayed in the formation of new electrical undertakings in the new kingdom of Czecho-Slovakia. After the launching of the Middle Moravian company, have followed an East and a West Moravian company, each with its separate district to serve. Now, the fourth and the last to be established is the North Moravian, with the object of electrifying Northern Moravia and the parts of Silesia on the border. The new company bears the name of "Nordmährische Elektricitäts Aktien Gesellschaft," and possesses a capital of 4,000,000 kronen. To the capital of the concern the State, the Province, and the communes affected contribute to the extent of 60 per cent., private capitalists to 35 per cent., and officials, workmen, and others, to 5 per cent.

The supply of electricity to the towns, rural districts, and industries of Western Bohemia, was a burning question before the war, and led to many but fruitless representations and negotiations with the former Governmental departments at Vienna. With the new order of things, the matter has been taken up by the Elektricitäts Verband der Nördlichen Bohmerwaldbezirke, representative of district deputies, provincial bodies, communes, and other consumers, and the question seeking solution now is either the erection of a distribution net work for the whole province with a single generating station worked by water alone, of which an ample quantity is available, or by heat in some form, or by a combination of the two systems. In favour of the last is the fact that resort must probably be had to heat reserve plant in the drier periods of the year, and that big works like the Skoda Co.'s works in the Pilsen coalfields and other works have large heat plants already available; but the decision depends upon the cost, and to serve the needs of the small as well as the larger consumers, choice must be made of that system entailing the least prime cost. So far as the peculiar circumstances of West Bohemia are concerned, the question is evidently very complex, and the result of the general deliberation will be awaited with interest.

The Moravian Provincial Commission has decided, after thorough examination, on the development of the water power of the river Thaya. The building of two dams and a weir, with a hydro-electric station at Znaim, was approved; 80,000 000 kWh yearly is expected to be the output of these works, which, with two additional weirs, cannot be completed under several years. Before the war, Swiss capitalists were interested in this scheme.

Dublin.—Water Power Possibilities.—In its report upon the possibilities of utilising the water power of the Liffey for the generation of electricity, the Corporation Electricity Committee points out the difficulties placed in the way of the electricity undertaking by the fuel shortage, and considers that from many points of view the harnessing of the Liffey would be of enormous advantage to the city. It is stated that when the question was first dealt with, it was considered that with coal at 10s. a ton, it would pay to undertake a water-power scheme with a maximum capital cost of £50 per h.p. developed. Now that coal costs 50s. per ton, that figure can be fixed at £200 per h.p. The report states:—

"Even if the water power were to cost more than the steam power, it would be well worth considering, as it would remove, to a large extent, the menace of a coal shortage. This, however, does not appear to be the case, and it seems quite probable that the water power will prove the cheaper. It is estimated that the Liffey development scheme would not cost much more than £100 per h.p. In other words, the power from the Liffey water-power works would cost little more than half as much as an equal amount of power from the Pigeon House works. In estimating ultimate costs it must be remembered that the capital costs already incurred by establishing the steam-power stations must continue to be carried until the capital expenditure has been paid off. Even when these costs have been taken into account, the water-power proposition would appear to have much to be said for it from the financial point of view.

"If water power were substituted for steam power for the generation of electricity for the supply of the present Dublin consumers, the result would be a saving of some 50,000 tons of coal per annum. This coal at 50s. per ton would cost £125,000 per annum, and this sum capitalised would amount to over 1¼ million pounds sterling. It will thus be seen that very large capital expenditure would be justified for the purpose of developing the Liffey water power."

Dundee.—Electricity Supply Discussion.—The Corporation's electricity problems were discussed at great length at a special meeting of the Town Council. Prof. Gibson was in attendance, and was thanked for the assistance he had given the Council in compiling reports on various schemes. The convener of the Electricity Committee declared that they must dismiss from their minds any idea of the city's exploiting hydro-electric power on its own account. It was decided to curtail the proposals previously passed to extend the steam generating plant, and to confer further with the Grampian Co. with a view of getting a favourable offer.

Edinburgh.—New Sub-station.—The Corporation Electricity Committee recommends that tenders be accepted for the erection of a sub-station in the Cowgate, which is estimated to cost £10,000.

Galashiels.—Proposed Purchase of Undertaking.—The Town Council is in communication with the Galashiels and District Electric Supply Co., Ltd., with regard to the proposed acquisition by the town of the company's undertaking. The company considers it is premature to enter into negotiations.

Gold Coast.—Electricity Supply Details.—The administration report of the Gold Coast Railways for the year 1919, just to hand, states that throughout that period the electricity supply to locomotive workshops and running sheds, Government offices, and for public and private lighting, had been maintained without interruption of service, and there was a marked increase in the quantity of electricity generated and supplied over the previous year's working. Private consumers' lighting load increased considerably, and more than 400 additional lighting points were installed.

Halstead.—Position of Supply Scheme.—The *Essex County Standard* states that only about £1,000 of the £8,000 required for the carrying out of the Halstead electricity supply scheme has been subscribed.

Hereford.—Extension of Supply.—The Corporation is applying to the Electricity Commissioners for a special order authorising the Council to extend its area of supply of electricity, so as to include therein the urban districts of Bromyard and Kington, the rural districts of Bredwardine, Bromyard, Dore, Hereford, Kington, Leominster, Ross, Weobley, Whitchurch, Wigmore, and parts of the urban district of Ross, and the rural district of Ledbury, the extension and amendment of the Hereford Electric Lighting Act, 1898, supply of electricity in bulk, construction and erection of overhead wires, and further powers with regard to revenue and reserve fund.

Kirkcaldy.—Need for Extensions.—The Corporation is in a difficulty so far as the future of the electricity undertaking is concerned. There is a desire to retain the undertaking rather than dispose of it to the Fife Power Co., but, believing the time premature to consider any scheme for a national power station in Fife, the only alternative would seem to be that of temporarily

extending the present generating station, at a cost of £70,000, and erecting a new power station later. The Corporation electrical engineer reports that there is no room on the existing site for further steam plant extensions to meet the needs of the town. He considers that a steam-turbine power station on a new site has become inevitable, and advises the purchase of two 750-b.h.p. land Diesel engines, with alternators, to be placed in a temporary building alongside of the existing station.

Littleborough.—Electricity for New Houses.—After considering the question of the supply of electricity to the housing site, the Tramways and Electricity Committee has recommended that the engineer submit revised estimates for the laying of cables to Hare Hill Mill, and thence to the housing site, for distribution cables thereon, the wiring of the houses, and for street lighting; also that application be made for borrowing powers, and that tenders be obtained for wiring the houses.

Mytholmroyd.—Mains Extensions.—The Urban District Council has given permission to the Yorkshire Electric Power Co. to lay more mains in the district, and also to proceed with the erection of an overhead cable from Mytholmroyd to Acre Mill.

Navan.—Electric Lighting Scheme.—At a meeting of the Urban Council, the Irish Commissioners of Public Works intimated, in reply to an application for a loan of £10,000 for an electric lighting scheme, that such loans were not now granted by the Commissioners. After discussion, it was decided to apply to the Munster and Leinster Bank for a loan of £10,000, repayable in 20 years.

Newport. — Cooling-water Investigations. — The Newport Harbour Board has given its sanction to a scheme put forward by the electrical engineer of the borough of Newport for the establishment of a single-unit pumping station for the purpose of making investigations to ascertain if the use of the river-water for condenser-cooling purposes is practicable.

Runcorn.—Power Co.'s Supply to Ellesmere Port. —The Mersey Power Co. has notified the Mersey Conservancy that it is about to lay cables in the bed of the River Weaver, near Weston Marsh Lock, for the purpose of conveying electrical energy from the Percival Lane power station of the company at Runcorn to Ellesmere Port. Five cables are proposed in all—three power cables and two telephone cables. The cables will be paper insulated, lead sheathed and double wire armoured. They will be laid in a dredged trench in the bed of the river on a solid clay foundation. No interference with tidal waters is anticipated.

Ryde (Isle of Wight).—Minimum Charge Protest.—The Town Council has decided to support the action of the Sandown Urban District Council in urging the Ministry of Transport to modify the order authorising the Isle of Wight Electric Light Co. to make a minimum charge of 50s. on the basis of a yearly consumption, instead of a charge based on a quarterly consumption, as at present.

Sevenoaks.—Proposed Price Increase.—The Electricity Co. has applied for an order to charge 1s. per unit for electricity, with quarterly minimum payments of 15s. in the winter, and 10s. in the summer.

Southampton.— Proposed Price Increase.—In a report to the Borough Council, upon the steps necessary to reduce an expected deficit of about £10,000 in the next financial year, the engineer states that re-organisation should be carefully considered in the first place. Next, he thinks that the prices charged for electricity for heating are too low, and suggests increases which would bring in an additional revenue of £6,286. A small increase in revenue could be effected by charging rentals for the power and heating meters. He states that he is very reluctant to recommend any further increase in lighting charges, although the Corporation's rates are probably the lowest on the South Coast. A special meeting of the Electricity Committee is to consider the report.

Southend.—Inspection of Second-Hand Plant.—At a meeting of the Electricity and Light Railways Committee, the electrical engineer reported that the Rotherham Corporation had laid down a new generating station and was disposing of a quantity of valuable plant from the station which had been closed, including four 30,000-lb. Niclausse boilers which had been in use for a period of two years, and which, if in suitable condition, could be utilised in connection with the new extension scheme, thus enabling a considerable saving to be effected. It was resolved that the chairman, Councillor Butterfield, and the electrical engineer attend at Rotherham for the purpose of inspecting the boilers and other plant which might be considered suitable for use in connection with the Southend scheme.

Street Lighting.—The Electricity Committee reports that it has had before it the question of reverting to the full pre-war standard of lighting in the streets of the borough, and has directed the engineer to submit a report upon the matter to the next meeting of the Committee. Particulars were submitted as to the charges for illumination with arc lamps, and in view of the high cost of this method of lighting, it wa decided to obtain an estimate from the electrical engineer of the cost per lamp of fitting and lighting gas-filled lamps on the existing arc lamp standards. The electrical engineer was also requested to inform the Committee at its next meeting when he would be in a position to supply electricity to the electric street lamps (other than arc lamps) at the pre-war standard of street lighting.

Offer of Bulk Supply.—The Town Council having received an offer for a future supply of electricity in bulk from the County of London E.S. Co., has replied that it will be willing to consider carefully any proposals put before it, and asks for particulars as to price, &c.

Stafford.— Separate Committees Recommended.—The Gas and Electricity Committee recommends that, owing to the size and importance of the two undertakings, the existing Committee should control the gas undertaking, while electrical matters should be dealt with by a separate Electricity Committee.

Swansea.—Supply to Amman Valley.—At a meeting of the Electricity Committee, with reference to the supply of electricity to the Amman Valley, the town clerk stated that he had heard from Mr. W. A. Chamen, the general manager of the South Wales Electrical Power Distribution Co., who suggested that if the Corporation desired to supply electricity over a large part of the company's area to the north of Swansea, including the Pontardawe area, an agreement might be arrived at for the transfer of some of the company's powers, and that he had asked Mr. Chamen to state the conditions (if any) to which the company would require the Corporation to agree. The town clerk also reported upon the position with regard to the completion of the agreements and the necessary formalities as to notices, &c., in connection with the supply. The town clerk was instructed to take all the necessary steps to complete the matter, so that the supply might be given on the appointed day.

Torquay.—Extensions Scheme Deferred.—The new electricity scheme, including the provision of a new generating station, has been put in abeyance for the present. It is considered that, having regard to the present financial position of the borough and the unsatisfactory condition of the money market, an expenditure of six figures could not be borne. It is hoped that the present works can be adapted to requirements for some years to come. An independent consultant is to be asked to advise the Electric Lighting Committee on the matter at the expiration of a month.

Torrington (Devon).—Electricity Supply Required. —The Town Council has made arrangements for the promoter of the electric light scheme at Bideford to meet the Council on the subject for providing electricity for the town.

Truro.—Transfer of Powers Refused.—The town clerk has been instructed to reply to a letter from the Electricity Commissioners that having interviewed Messrs. Herd & Smith, Ltd., the Corporation is not prepared to transfer its electric lighting powers to that company.

United States.—Water Power Concessions.—The Federal Power Commission has granted the application of the Southern California Edison Co. for a 200,000-h.p. hydroelectric development on the San Joaquin River, Cal., part of a $100,000,000 project contemplated by the company. The commission has also granted a 50-year licence to the Niagara Falls Power Co. to use 19,500 cb. ft. a second of the 20,000 cb. ft. of water permitted by a treaty with Canada to be diverted from the Niagara River above Niagara Falls. The commission has also approved an application by Mr. Henry Ford for a power development project at Troy on the Hudson River to cost $2,500,000 as the power source for a projected motor factory, involving $7,500,000.—*Reuter's Trade Service* (Washington).

Wallasey.—Cause of Deficit.—Instead of providing £8,500, the Wallasey electricity undertaking has finished the year with a loss of £7,000. This result is due to the extra consumption of fuel owing to the breakdown of two turbines in May and June last. In order to maintain the supply to the tramways and industrial undertakings, the supply was kept going, but with excessively high working costs. Since the repairs have been carried out, the fuel consumption has fallen from 5·5 lb. to 3·42 lb. per kWh. The deficiency on the year is carried forward, and although an increase of ½d. per unit is proposed, it is anticipated that a surplus of £5,900 will be achieved in 1921-1922.

Wigston Magna and District.—Extension of Supply. —The Midland Electric Corporation for Power Distribution is applying to the Electricity Commissioners for powers to generate and supply electricity within the urban district of Wigston Magna, &c., the parish of Bedworth, &c., and Bulkington, Atherstone, and district, &c.

TRAMWAY AND RAILWAY NOTES.

Aberdare.—Year's Working.—The accounts of the tramway department, which combine the accounts of the tramways and omnibuses, for the year ended March 31st, 1920, show a total revenue of £30,162, as compared with £26,820 for 1918-19. Working expenses amounted to £25,485, as against £18,003, leaving a gross profit of £4,677, to which the tramways contributed £4,922, while the 'buses incurred a loss of £245. The net result was a profit of £149; the net profit of the previous year was £2,598.

Birmingham.— Report on Electric Vehicles. — Some interesting figures are contained in a recent report by the superintendent of the Salvage Department to the Council. The report says there are now 32 electric vehicles engaged in the collection of refuse, and the work has been facilitated to a ver

great extent. Whereas two horsed vehicles and four men are only able to attend to 1,692 houses per week, one electric vehicle, with the same number of men, visits 2,116 houses per week. The cost of the horsed vehicles works out at 3·22d. per house per visit, while the equivalent cost of the electric vehicles is 2·94d., a saving of ·28d., or about £125 per annum for each electric vehicle. It is estimated that apart from this saving, each electric vehicle saves at least another £125 on account of its releasing two horsed wagons for the inner areas where the work of collection is easier.

Blackpool.—Success of System.—It is interesting to note that from 1893 up to the present date, the tramways have contributed £132,497 to the relief of the rates. Blackpool was the pioneer town in electric tramcars in the country. In 1884 a syndicate laid a length of 2 miles along the Promenade, worked by electricity, and the service was opened with the late Mr. J. Lancaster as manager. The lease expired in 1892, and the Corporation took over the undertaking. At that time Plymouth and Huddersfield were the only towns working their own tramways. The first year at Blackpool resulted in a net loss of £603, but there has not been a loss since then. The average net profit for the last 28 years has been over £9,600 a year.

Bradford.—Reduction of Services.—The short-time being worked in the local textile trades has caused the Tramways Committee to reduce materially the early morning car service on several of the city routes, and this cutting down is being extended to other routes.

Brighton.—Temporary Fare Reductions.—Owing to a considerable falling-off in the number of passengers carried since the introduction of higher fares, the Corporation has decided to revert to 1d. fares for three months as an experiment. It is stated that the extra revenue is not as large as had been anticipated, amounting to only £12,000.

Fife.—Charged Tramcar Handrail.—While a tramcar was proceeding along the High Street, at Cowdenbeath, Fife, a man coming down the stair from the top of the car was seen to be in distress. The car was brought to a standstill, and it was found that the stair-rail of the car was charged with electricity. After great difficulty, the pole was taken off and the man was released in an unconscious state. He was removed to hospital.

Glasgow.—Subway Electric Trains Proposed.—Authority was given by the shareholders to the directors of the Glasgow Subway Railway Co. recently to close the line temporarily to traffic whenever that appeared to be in the interests of the company. In the past year revenue fell short of expenditure by £15,327. A shareholder raised the question of running trains with electrical accumulators. The chairman said this was possible, but it was a question they could not face on account of cost.

Ipswich.—Additional Electric Vehicles.—Owing to the great saving effected by the substitution of two electric vehicles for nine horses and carts, thereby reducing the cost of refuse collection from 18s. 3d. to 11s. 4d. per ton, the Town Council has decided to apply for permission to purchase two additional 3½-ton electric vehicles at a cost not exceeding £1,750 each.

London.—Traffic Regulation Bill Postponed.—In reply to a question put to him in the House of Commons, on March 21st, Sir Eric Geddes (Minister of Transport) said that the report of the Select Committee on London Traffic had been carefully considered, but the proposal to set up a London County Transport Authority was a highly contentious one. In addition to this, in view of the general need of economy in Imperial and local expenditure, it was not desirable to proceed with the Bill at present.

"Linking-Up" Recommended.—With the object of expediting tramway traffic along the Embankment, the London County Council is recommended to institute further "circular routes," linking up certain services and so reducing the number of cars turned on the Embankment. The new connections to be provided under the scheme include Forest Hill and Embankment *vid* Brcokley and New Cross, Southcroft Road and Embankment, Norwood and Embankment, and Peckham Rye and Embankment. Direct tramway communication will be afforded between Catford and the Embankment.—*Morning Post.*

Augmented Services.—On and after March 30th, the London United Tramways will increase its tramway service between Shepherd's Bush and Hanwell during the morning and evening busy hours. In place of the present four-minute interval, the service will be increased to run at three-minutes' intervals, and will operate thus between 7 a.m. and 9.30 a.m. and between 4.45 p.m. and 7 p.m. from Shepherd's Bush.—*Financial Times.*

London Electric Railways.—Extension of Time.—The Minister of Transport has extended the time until August, 1922, of the London Electric Railway Act, 1913, for the construction of works, &c.

Newcastle.—Proposed Railway Electrification.—The Newcastle-upon-Tyne Electric Supply Co. announces that negotiations are proceeding with the North-Eastern Railway Co. for the electrification of a portion of the main line.

Portsmouth.—Reduction of Services.—In an endeavour to reduce the working costs, in view of the serious deficit incurred since the introduction of higher fares, the Corporation has decided to substitute a six-minute service for the existing five-minute service. In order that the whole of the present staff may be retained shorter hours are to be worked by the men; the average loss to each is 9s. per week.

South Yorkshire.—Tramway Scheme.—An inquiry by the Ministry of Transport is to be held into a joint scheme of the Urban District Councils of Wombwell, Wath-on-Dearne, Bolton-on-Dearne, and Thurnscoe to construct 16 miles of tramway between Barnsley and Mexborough, at an estimated cost of £300,000. What is being asked for is confirmation and certain extensions of the original Dearne District Light Railway Order, 1915, the operation of which was postponed on account of the war.

Sunderland.—Tramway and Rates.—At a meeting of the Town Council, Councillor G. S. Lawson, speaking on the estimates, proposed that the item of £5,000 from the tramways in relief of rates—which the Committee is unable to provide next year—be restored. He said this sum was really the rent of the street, and ought to be paid, no matter what went without. If the tramways were leased to a private company, they would have got more from them than the Corporation had got from running the tramways, without risking any of the ratepayers' money. Replying, Alderman New, chairman of the Committee, pointed out that the contributions to reserve and renewals fund for several years had been considerably less than the amounts they had taken out. The tramways had paid altogether £70,000 in relief of rates, £65,000 in rates, and £37,000 in renewal of track to the Highways Committee.

TELEGRAPH AND TELEPHONE NOTES.

Argentina.—New Wireless Station.—The Government has granted a concession to the General Wireless Telegraph Co., of Paris, to construct on the Argentine coast a wireless telegraph and telephone station to communicate with France and other European countries. The company, it is stated, expects to establish telephonic connection between Paris and Buenos Aires by a system of continuous waves. The duration of the concession is for 30 years; it authorises the company to carry on experiments in long-distance wireless telephony, and if at the end of three years the experiments are considered by the Argentine Government to be satisfactory, the concession will be extended to permit commercial exploitation of wireless telephone as well as telegraph communication. Three sets of plant are to be erected, and the station will be of 800-kW capacity.—*Reuter's Trade Service* (Buenos Aires).

Germany.—Telephone Service.—In a lecture, delivered last October, before the Reichsbund deutscher Technik (German Technical Union), Dr. Bredow outlined the financial position of the German telegraph and telephone service (2,000 million marks deficit in 1920), and suggested remedies for improving the position. The gist of the lecture as reported by the *Reichsbundes deutscher Technik* is that the large deficit is due to the extraordinary rise in the cost of materials and labour; the prices for iron wire have increased 3,000 per cent.; for copper wire 1,200 per cent.; for underground cable, 2,000 per cent.; cable and flexible for internal connections, 3,000 to 4,000 per cent.; and telephones, 2,000 to 3,000 per cent. Both systems are at present strained to their highest possible capacity, and extensions must be undertaken at once. Prior to the war, the cost of a telephone line in Berlin was Mk. 800, and is now Mk. 11,000, while the cost of working and maintaining a line has increased tenfold. Although the telephone fees have increased to about four times the pre-war rates, further drastic alterations are contemplated; the unlimited service rate will be abolished, and a tariff introduced based on the number of calls made—the subscriber having the greatest number of calls paying the highest fees. The cost of installing the telephone has already been increased, and increased revenue is expected from that direction, owing to the large number of prospective subscribers. A compulsory loan is also contemplated, and it is expected that as the result of this and other measures to be taken, the financial situation will improve in time; but it will be many years before the services reach their pre-war level of efficiency.—*Technical Review.*

Ireland.—Telephone Service.—It was reported on March 16th that the telephone wires in different parts of Ireland were cut on an extensive scale. Early on the 16th inst. Belfast was isolated from many parts of the country, and as a number of linesmen and mechanics were leaving the Central Exchange in Dublin they were held up by armed men, who took from them all their equipment. This sort of thing has been taking place periodically for some time past.

Railway Telegraphs.—Maintenance.—It is stated that the railway companies maintain on behalf of the Post Office 61,500 miles of telegraph and telephone wires, and that in respect of their maintenance £63,000 per annum is paid.

Switzerland.—New Wireless Station.—Marconi's Wireless Telegraph Co. has been authorized by the Swiss Federal Government to construct a wireless telegraph station for operation over a period of 25 years by a Swiss company. The station, which is to be erected near Berne, about 1,800 ft. above sea level, will employ a Marconi valve continuous-wave transmitter of 25 kW capacity, the aerial being carried on two towers, each 300 ft. high. Up-to-date apparatus for high-speed automatic working will also be employed. The new station, which will afford special facilities for Press traffic, besides conducting a commercial telegraphic service with England and other European countries, will be ready for use by journalists attending the second session of the Assembly of the League of Nations in September next. It will be recalled

that in November last Marconi engineers erected at Geneva, in the record time of nine days, a temporary station which materially assisted the international journalists attending the first Assembly of the League.

United States.—Telephone Rate Increases.—The New York Telephone Co. is to increase its rates by 28 per cent. as from April 1st. In asking authorisation for this increase, the company argued that the payment of increased salaries and other additional expenses, amounting to $11,000,000, had made the step necessary.—*Reuter's Trade Service* (New York).

CONTRACTS OPEN AND CLOSED.

(The date given in parentheses at the end of the paragraph indicates the issue of the Electrical Review *in which the "Official Notice" appeared.)*

OPEN.

Australia.—Melbourne.—April 27th. Victorian Railway Commissioners, Spencer Street. Caustic soda primary cells, complete (Contract No. 33,914).*

May 2nd. Victorian Railway Commissioners. Twelve miles of ·015 sq. in. two-core, lead-sheathed, wire-armoured, 2,200-V cable.*

June 22nd. Victorian Railways. One electric lifting magnet (capacity ½ ton), one 440-V motor generator.

June 29th. Supply of 1-ton platform type industrial storage battery trucks, also battery charging equipment.—*Reuter's Trade Service* (Melbourne).

Morwell Power Scheme. The Electricity Commissioners of Victoria have made certain alterations, alternatives with additions, to the specifications which will necessitate tenderers cabling any consequent amendments of their tenders before March 31st. (March 18th.)

Bedford.—March 31st. Electricity Department. Electricity meters, h.p. and l.p. cables, for 12 months. (March 18th.)

Belfast.—April 25th. Electricity Department. E.h.p. and l.p. switchgear. (March 18th.)

Belgium. — April 6th. The Société Nationale des Chemins de Fer Vicinaux, 14, Rue de la Science, Brussels. Laying of the underground armoured cables required in connection with the supply of electricity to the lines in the Louvain section. Particulars can be obtained for 3 francs from the Services Electriques, 48, Rue Montoyer, Brussels.

April 11th. The municipal authorities of Schaerbeek, Brussels. Supply of a quantity of electric cable. Particulars can be obtained from the Service d'Electricité, Hotel Communale, Schaerbeek.

Jugo-Slavia.—May 1st. The Serb, Croat, and Slovene Ministry of Public Works. Erection of a power-station, main conductors and transforming stations in connection with an electrical scheme at Kostolac for the supply of energy to Belgrade, Semlin, &c.*

The Commercial Secretary to H.M. Legation at Belgrade reports that a prominent business man and proprietor of flour mills in Serbia is contemplating the installation of a complete electric lighting and power station, and is asking for tenders for the necessary plant, which includes one steam engine of 150-h.p., generators, &c., for power for 4,000 to 5,000 lamps (about 90-kW), and overhead cables and conductors for 60 kilometres of circuits (to provide lighting for about 1,400 houses). The name and address of the inquirer may be obtained by United Kingdom firms interested, on application to the Department of Overseas Trade in London.

Canary Islands.—April 7th. The Cabildo Insular de Teneriffe, at Teneriffe, Canary Islands. For the establishment of a telephone service between Santa Cruz de Teneriffe and Guimar.

Cardiff.—April 11th. Welsh National Memorial Association. Electric lighting plant for the Glan Ely Sanatorium. Two 20-kW internal-combustion engine-driven generator sets, battery charging booster, switchboard, battery of accumulators. (See this issue.)

East Ham.—April 2nd. Electricity Department. L.p. paper-insulated, lead-covered, armoured concentric cable, with necessary joint boxes, &c.; also two c.i. lighting feeder pillars. (March 18th.)

France.—April 5th. The French State Railway authorities, 43, Rue de Rome, Paris. Supply of four 8-ton electric travelling cranes for the new railway workshops at Sotteville-Quatre-Mares, Rens. Particulars may be obtained from the Services Electriques (1st Division) at the above address.

April 1st. The French Post and Telegraph authorities at 24, Rue Bertrand, Paris. For the supply of two accumulator charging boards and four sets of current converters for use in connection with the charging of accumulators.

Glasgow.—April 2nd. Corporation Electricity Department. Works required in connection with erection of sub-station in Buchanan Street. Corporation Engineer.

London.—H.M. Office of Works. April 12th. Supply of electrical labour-in-daywork in the Leeds district. (March 18th.)

L.C.C. April 18th. 5,500 tons of standard steel girder tramway track rails, lipless track rails and renewable guard rails with fastenings. Chief Engineer, County Hall, Spring Gardens, S.W.1.

Manchester.—April 7th. Electricity Committee. High-pressure steam and water valves; high-pressure steam and water pipes, steam receivers, &c.; weighbridges and automatic coal-weighing machines; electric and hand-operated cranes. (March 11th.)

South Africa.—Pretoria.—May 10th. Municipality. Switchgear. Tenders, marked "Electric Light and Power Department, 1920 Extensions, Contract No. 5," to Deputy Town Clerk, Municipal Offices, Pretoria, on May 10th. Deposit, five guineas. Further particulars may be obtained from the general manager of the Electric Light and Power Department, or from the consulting engineer, Mr. G. M. Clark, 40-42, Meischkel's Buildings, Johannesburg.

Johannesburg. — June 22nd. South African Railways and Harbours. Electrification of Capetown and Simonstown and Durban-Maritzburg lines; Capetown and Simonstown lines: Overhead equipment of permanent way and overhead transmission line, switchgear and accessories, and trackbonds; Durban-Pietermaritzburg line: Overhead equipment of permanent way, overhead transmission line, switchgear and accessories, and trackbonds. (See this issue.)

Wimbledon.—March 29th. Electricity Department. Annual contracts for cables and conduits, joint boxes and jointing materials, transformers, meters, &c., lubricating oils. (March 11th.)

Worksop.—April 6th. Electricity Committee. E.h.p. and l.p. cables; e.h.p. and l.p. switchgear; transformers; 500-kW rotary or motor converter. (March 11th.)

* A copy of the specification, &c., can be consulted at the Department of Overseas Trade, 35, Old Queen Street, S.W.1.

CLOSED.

London.—St. Pancras.—Borough Council Electricity Committee:—

Fitting travelling grate stoker to two Babcock & Wilcox boilers at the King's Road station, £3,898.

Six switchboard panels at Regent's Park station.

E. F. Moy, Ltd. (recommended)	£310
Northcote, Heaver & Co.	343
W. White & Co.	345
Park Royal Engineering Works, Ltd.	315
Collins Electrical Co., Ltd.	375
Bertram Thomas	453
Switchgear & Cowans, Ltd.	493
Ferguson, Pailin & Co.	479

Steel stanchions, framework, and extension of platform to support these proposed new panels.

Measures Bros., Ltd. (recommended)	£75

Rotherham.—Housing Committee. Accepted:—

Electric lighting installation—100 houses in the Doncaster Road scheme.—Lilleker Bros.

FORTHCOMING EVENTS.

Edinburgh Electrical Society.—Friday, March 25th. At the Philosophical Institute. At 8 p.m. Paper on "Automatic Telephones," by Mr. W. Leithead.

Manchester Association of Engineers.—Saturday, March 26th. At the Memorial Hall, Albert Square. At 7 p.m. Annual general meeting. Paper on "Fire Extinguishment by Mechanical and Other Means, including Sprinkler Installations," by Mr. J. T. Clarke.

Institute of Marine Engineers.—Tuesday, March 29th. At the Institute, The Minories. At 6.30 p.m. Presidential address by Lord Weir.

Junior Institution of Engineers.—Friday, April 1st. At 39, Victoria Street, S.W. At 7.30 p.m. Paper on "Pneumatic Conveyors," by Mr. M. Jennings.

Manchester Wireless Society.—Friday, April 1st. At the Manchester College of Technology. At 7.30 p.m. Lecture on "Direction Finding," by Mr. J. Hollingworth.

Institution of Production Engineers.—Saturday, April 2nd. At 2 and 4, Tudor Street, E.C. At 6 p.m. General meeting to approve articles of association and by-laws.

NOTES.

Commercial Motor Parade.—The annual parade of commercial motor vehicles, organised by the Commercial Motor Users' Association, will take place at Lincoln's Inn Fields, on April 2nd.

An Automatic Train Indicator.—We are informed that Messrs. Indicators, Ltd., have fitted one of the trains on the Great Northern and City section of the Metropolitan Railway (Finsbury Park to Moorgate Street) with progressive station indicators. These electrical devices, which, it will be remembered, were described on page 60 of our issue of January 9th, 1920, intimate to the travelling public the progress of the train, showing automatically the next stop, all stops, non-stop stations, and so on. The indicator keeps up to date at each station; it is fitted in the roof of the car, and can be seen from any part of the corridor coaches.

Fatalities.—Four men were fatally gassed at the electric power station of the United Alkali Co., at Widnes, on March 15th. Coal is mechanically conveyed into the furnaces, and the resulting ashes and clinkers are also mechanically removed into a large cylinder, and thence into wagons placed at the bottom. During the afternoon a passage in a large cyclinder, through which the ashes go, became blocked, and two men, Russell and Worth, entered the cylinder to try and remove the stoppage. As they did not return, two others, Hallwood and Saunders, also went down. All were gassed, and several would-be rescuers who entered the cylinder were driven out by gas. A workman, protected with a gas-mask, afterwards recovered the four bodies.—*The Times.*

Educational.—Borough Polytechnic Institute.—On Saturday last the annual exhibition of students' work was held; it included demonstrations in the departments of engineering and electrotechnics, and exhibits of the work of pupils in the technical day school and evening classes.

Cardiff Technical College.—The Committee has received a cheque for £18,000 as a donation from Sir William Smith, Mr. Frederick Jones, and others interested in the shipping industry, to the Nautical Instruction Department of the College.—*The Times.*

Third Annual Re-Union of the Ex-British Westinghouse Association.—Annual dinners of Old Boys' and similar associations frequently become stereotyped, and, therefore, boring, finally fizzling out altogether. The annual re-union of Ex-British Westinghouse men will be a long time reaching this stage, judging by last Friday's third gathering at the Holborn Restaurant, London, under the chairmanship of Mr. M. M. Gillespie. The idea of re-union has always been prominently before the Committee, and the hon. secretary, Mr. L. S. Richardson, and this year the company of about 150 was "departmentalised" at separate tables, seating about eight or ten, appropriately labelled:—Upper dining room, G. Aisle, K. Aisle, G. Copper, A. Punch, Brass Foundry, Transformer Test, Pattern Shop, Paint Shop, Iron Foundry, Dipping Shop, Dynamo Test, Boiler House, and B. Aisle. This plan was a huge success, and each member had his corresponding clock card; neither ordinary nor overtime was paid, because everything was at "piece" rates, including the toast-list. The latter included "The Association," proposed by Mr. J. S. Peck, and replied to by the chairman, and Mr. J. Turnbull (still bearded); "The Chairman," humorously presented by Mr. R. G. Mercer (who forgot the show was morning dress); and "Absent Friends and Old Associates," by Mr. G. Layton. Major O. P. L. Hoskyns called on the company for the "Silent Toast to the Memory of Ex-B.W. Men."

The items in the musical programme by Mr. A. P. Ambler, Mr. Val Wood, and Mr. H. S. Aspinall and Miss Muriel Macgregor, were just sufficient not to interfere with the renewal of old friendships. The members also had opportunity to exhibit their vocal powers in the opening and closing chorales; the latter to the tune of "John Brown's Body."

During the evening the opportunity was taken to make a presentation to the hon. secretary and re-union agitator, Mr. L. S. Richardson, for the valuable services he has rendered in assisting in the formation of the Association and organising the first three functions. The gifts were an after-dinner coffee set with silver spoons, a gold watch-fob, and a gold bracelet watch for Mrs. Richardson. Mr. Aspinall introduced the subject in a speech of appreciation and thanks, and Mr. Gillespie made the presentation in a particularly happy manner. Mr. Richardson, in reply, mentioned from experience how little incidents often made great impressions, and that it was undoubtedly that *esprit de corps*, from the managing director downwards, which existed in the old days, that made it always a pleasure and privilege to assist in keeping fresh old B.W. friendships.

The souvenir programme was in great demand, and no further copies are now available. Ex-B.W. men are reminded that new names and over-due "subs." (without which the good work of the Association cannot go on), should be sent to the Hon. Sec., Mr. L. S. Richardson, 14, Sydney Road, Richmond, Surrey.

Rain-Making Again.—According to a Reuter message in the *Manchester Guardian*, the United States Government is now in the rain-making business. Experiments conducted by the Air Service under the War Department, prove that precipitation can be brought about by electrostatic influences, an aeroplane serving as the medium to persuade the clouds to release their moisture. It is stated that showers have already been precipitated in secret trials, and experiments on a large scale are to be conducted this month.

Appointments Vacant.—Assistant electrical engineer (Rs. 400 to Rs. 600 per mensem), for the Madras and Southern Mahratta Railway; charge engineer, for the Bootle Corporation Electricity Works; engineer-in-charge and assistant mains engineer for the Hammersmith Borough Council Electricity Department. See our advertisement pages to-day.

Electrotechnical Meetings in Germany.—The second "Electric Week" is to be held this year in Essen from May 29th to June 2nd. This institution, by which all the great electrotechnical unions and associations of Germany—to the number of 12—hold their meetings together under the direction of the Verband Deutscher Elektrotechniker, took place last year for the first time in Hanover, where it met with general approval. A special attraction for all the circles interested in the re-establishment and development of the technical industries is the holding in Essen of a three-weeks exhibition of electrotechnical products. The exhibition will, in the first place, set forth the basis on which, up to the present, the development of electrotechnics has moved; it will also display the progress made in the electrotechnical world for the general good.

INSTITUTION NOTES.

Institution of Electrical Engineers.—North-Western Centre.—A popular lecture on "Developments in Wireless Telegraphy and Telephony" will be delivered by Prof. E. W. Marchant, D.Sc., M.I.E.E., on April 6th, 1921, at the Municipal College of Technology, Manchester. Prof. Marchant hopes to arrange demonstrations of wireless telegraphy and telephony, and his lecture should be of particular interest. The lecture will be open to the public, but to ensure members and their friends obtaining seats, tickets will be issued on application, which must be made not later than March 30th.

Informal Meeting.—At the meeting of the Informal Section, on the 14th inst., with Mr. A. B. Eason in the chair, a discussion was opened by Mr. R. L. Morrison on "Mercury Arc Rectifiers," and was thoroughly successful. The opener was furnished with some good photographs of rectifiers in service, and with excellent charts and drawings, including a full-scale one of a 900-amp. converter. He explained the function and construction of the rectifier, and claimed superiority for the mercury arc rectifier, chiefly because of its high power factor, and saving in floor space and weight, also because it was noiseless, vibrationless, stationary, and required no heavy foundations.

There followed a keen and animated discussion. Mr. G. A. Juhlin thought the simplicity of the apparatus was bound to occasion its adoption and development, but disputed that rotary converters were at a disadvantage. He asked for information regarding possible interferences with telephones due to the ripples and harmonics. Mr. W. E. Rogers, Mr. W. E. Bradshaw, Major R. Grierson, Mr. P. Kemp, and 13 other speakers (Messrs. C. A. Newell, E. W. Moss, A. G. Hilling, W. H. J. Holloway, J. Aylmer, W. L. Wreford, M. R. Gardner, A. B. Eason, F. Pooley, H. M. Sayers, H. Cooch, E. W. Webb, and G. A. Cheetham) followed. The general trend of the discussion was very critical, and Mr. F. Pooley, who spoke late in the evening, urged that antipathy to the novelty of the apparatus was hardly constructive. Nevertheless, some useful ideas were mooted, and the evening was extremely interesting.

Mr. Morrison, in his reply, was able to point to extensive installations of the rectifiers, and though he agreed that the experience of them was only of a few years' duration, the makers were able to declare that the renewals and maintenance charges were negligible. With regard to telephone disturbances, no data were available, but no complaints were known of. Research and developments were proceeding, and at an early date it was anticipated that any d.c. ripple would be entirely eliminated.

A full description of the rectifier, by Mr. Morrison, was published in our issues of February 18th and 25th.

Institution of Production Engineers.—A general meeting of the Institution will be held on April 2nd, at 6 p.m., at 2 and 4, Tudor Street, London, E.C. 4, when the articles of association and by-laws, which have been drafted by the Provisional Committee, will be submitted for the approval of the meeting. All interested, and particularly prospective members, are invited to attend, and to signify their intention of being present to the Hon. Secretary, Mr. A. T. Davey, 6, St. James's Square, Holland Park, Kensington, W. 11, in order that the necessary arrangements may be made.

Manchester Wireless Society.—On March 9th, at the College of Technology (Mr. J. C. A. Reid in the chair), Mr. J. McKernan delivered a lantern lecture on "The Construction of Electric Motors." Starting with the theory of the subject, the earliest and the modern types of electric motor were described, and the various processes in their manufacture, repair, and maintenance were dealt with. The subject was made quite clear by many working models and parts shown by the lecturer, and by an excellent series of lantern slides.

Birmingham and District Electric Club.—On March 12th a paper was read by Mr. H. C. Young, A.M.I.E.E., upon "Common Sense Methods of Recording, Costing, and Progress in Shop Management." Mr. Young gave much valuable information from his own experiences in the management of large works. He insisted upon the importance of rapidly understood graphic records of day-by-day and, in some cases, hour-by-hour progress. Such records should be simple and easy to understand, kept regularly posted and displayed where everyone interested would see them, so that as soon as the actual line fell below the datum line, steps could be at once taken to investigate causes.

Chief Technical Assistants' Association.—The annual general meeting of the Association was held on March 5th. The retiring chairman, Mr. A. P. MacAlister, A.M.I.E.E., reviewing the work of the past year, referred to the recognition of electricity supply staffs through the activities of the E.P.E.A., and reminded the members that Mr. J. H. Parker, A.M.I.E.E., a former chairman of the C.T.A.A., was deputed to represent the Association on the Council of the E.P.E.A., and owing to his ability, he was elected president, and had contributed greatly to the success achieved.

Mr. J. R. J. Bowden, A.M.I.C.E., A.M.I.E.E., was elected chairman, and in thanking the members for the honour recalled the fact that his predecessor in the chair, Mr. A. P. MacAlister, was the founder of the C.T.A.A., and that the Association was the forerunner of the organisations which had set out to establish the fact that besides Capital and Labour there was a third party in the industrial world to be taken into consideration—the technical staffs.

Illuminating Engineering Society.—At a meeting of the Society, held on March 17th, a paper entitled "Motor-Car Headlights: Ideal Requirements and Practical Solutions," was read by Major A. Garrard, and followed by a discussion. The author dealt with

the effects of "dazzle," and means of combating them. The efficiency of various types of beams was discussed, and some information was given regarding regulations framed in this country and the United States. The limiting of the candle-power or diameter of the beam was not considered satisfactory. The use of parabolic reflectors was commented upon, the author stating that the size of the filament of an electric lamp prevented perfect focusing. The paper concludes:—"It would appear that the American devices have only been tolerable by reason of the slow driving necessitated by the generally bad cross-country roads there. In this country and in many other European countries a much higher standard of safe illumination is necessary, and will become more so, while the road improvements now going on in the States will at no distant date render a solution there equally necessary."

Royal Institution.—Amongst the lecture arrangements at the Royal Institution after Easter, are the following:—Dr. C. T. R. Wilson on "Thunderstorms" (the Tyndall Lectures); Mr. H. S. Foxwell on "Nationalisation and Bureaucracy"; and Mr. E. C. C. Baly on "Chemical Reaction." The Friday evening meetings will be resumed on April 8th, when Dr. R. H. A. Plimmer will deliver a discourse on "Quality of Protein in Nutrition." Succeeding discourses will probably be given by Mr. Ernest Law, Sir James Walker, Sir Frank Dyson (Astronomer Royal), Sir Robert Robertson, Dr. Bateson, Dr. Starling, Mr. A. Mallock, Dr. Leonard Huxley, Dr. A. G. Webster, Sir J. J. Thomson, and other gentlemen.

Institution of Civil Engineers.—At the ordinary meeting of the Institution on March 8th, Mr. Stephen Leggett, Member, read a paper on "The Amritsar Hydro-Electric Irrigation Installation." In this paper the author described the construction of a power station built on the Upper Bari Doab Canal at a point where a head of 58 ft. was available. The station contains three low-pressure turbines coupled to alternators through gearing, and has an output of 525 kW. Two h.p. transmission lines are carried to sub-stations on steel lattice towers, strong enough to stand unsupported should all the wires on one side break suddenly. They are set in concrete blocks and are spaced 300 ft. apart in open country. The sub-stations contain three single-phase oil-cooled 6,600/500-V transformers, and the pumps are started from the sub-station switchboard. A special sub-station is provided for transforming alternating current to direct current for the Central Workshops of the Punjab Canal System. Each sub-station feeds six pumps, the designed capacity of the power-station being 40 pumps, together with the workshops; this can only be obtained when the fall is increased to 9·7 ft. The pumps are direct-coupled to 15-h.p. 500-volt electric motors running at 970 r.p.m. Owing to difficulty in obtaining suitable pumps from British makers, the author designed a single-stage turbine pump, which was made in the Central Canal workshops.

Institution of Civil Engineers of Ireland.—Mr. Francis Bergen, President of the Institution of Civil Engineers in Ireland, lecturing before the members in Dublin on "Hydraulic Power for Industrial Development," said the growing demand for the development of industries in Ireland required a means of supplying power at a cheap rate for factories, &c. The many loughs and rivers of Ireland were waiting to give their powerful assistance to the industrial movement, and it was possible to construct dams in various places for storing the excess water in winter and during non-working hours. Should a pipe be brought from the Roundwood (Co. Wicklow) city waterworks reservoir to Dublin, the pressure would be 180 lb. per sq. in.

Röntgen Society.—A meeting of the society will be held at Manchester on May 6th, at the University, when Prof. Sir W. L. Bragg will read a paper, and Prof. A. V. Hill will give a demonstration of some electro-physiological experiments. On the following day it is hoped to arrange visits to works of scientific interest in the district. The gallery of the Royal Photographic Society of Great Britain has been placed at the disposal of the society during June, and it is hoped that a collection of radiographs, illustrating the different practical applications of X-rays, will be furnished by members of the society. The President of the Röntgen Society, Dr. Robert Knox, offers a special prize for work submitted by lay assistants engaged in the production of photographic results, working either as hospital assistants or as assistants to medical radiologists. Further details will be available in April.

Institute of Metals.—A London Local Section of the Institute has just been formed; the chairman is Dr. O. F. Hudson, of the Admiralty Engineering Laboratory, and the hon. secretary is Mr. D. Hanson, M.Sc., of the National Physical Laboratory, Teddington. Membership is available to persons resident within 50 miles of the G.P.O. No subscription is required of Members of the Institute of Metals, but non-members of the parent body, when elected as Associate Members of the Local Section, pay an annual subscription of 5s. On March 31st Mr. S. L. Archbutt is to read a paper on "Aluminium Alloys," and on April 21st Dr. W. R. Ormandy will present a paper on "Refractories." The London Section already has a membership of over 200.

The report of the Council, presented to the annual general meeting on March 9th, shows that the membership has increased during the year from 1,213 to 1,298. The expenses amounted to £3,620, and the gross income to £4,174.

South African Institute of Electrical Engineers.—At the twelfth annual general meeting, held in Johannesburg on January 20th, Mr. L. B. Woodworth took office as president. It was stated that the total membership had risen from 355 to 489. A vice-president and seven new members of Council were elected.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

The St. Pancras Borough Council has had under consideration the salary of the deputy electrical engineer under the agreement arrived at between the National Joint Board of Employers and members of the staffs (electricity supply industry). When the Council adopted the award in July, 1920, it was stated that his salary was not affected, but that as soon as the new 3,000-kW set was installed at the King's Road station he would be entitled under the schedule to an increase of £108 per annum. The total plant capacity of the undertaking on June 1st, when the award came into force, has now been assessed at 8,025 kW, instead of 7,900 kW, as previously reported to the Council; the difference is due to the bulk supply being estimated, in the first instance, at 400 kW, whereas the record actually shows that it should have been 525 kW for the preceding financial year. The following agreement with the E.P.E.A. has been arrived at:—That from June 1st, 1920, the salary of Mr. Baron shall be increased from £660, plus house, coal, and light, to £808, plus house, coal, and light, and from November 1st, when the increased plant came into operation, to £840, plus house, coal, and light. These figures include 5 per cent. extra for employés engaged in undertakings in London, but the salary is not affected by variation in the cost of living unless it drops below 110 per cent. The Electricity Committee is in agreement with the decision, and recommends acceptance.

The Halifax Tramways Committee has appointed Mr. Ben Hall, of Wigan Corporation tramways, as general manager of the Halifax tramways. Mr. J. W. Galloway continues to retain the post of tramway engineer.

Proposed increases in the salaries of several officials were rejected by the South Shields Town Council. One proposal was to increase the salary of the tramway manager from £600 to £700 a year, the voting being 12 for and 24 against. Another defeated recommendation was to increase the electrical engineer's salary from £700, and place it on a sliding scale according to the number of units sold, which would mean an immediate advance of £185 per annum.

According to a financial contemporary, Mr. Knibbs, the Australian Commonwealth Statistician, has been appointed Director of the Bureau of Science and Industry, at a salary of £2,000 per annum.

The Times states that the Secretary for Mines has appointed Mr. F. H. Hatch, Ph.D., M.Inst.C.E., to be technical adviser to the department on questions relating to the metalliferous mining industry.

Shrewsbury Town Council has increased the salary of Mr. F. C. Chester, assistant engineer at the electricity works, from £252 to £300 a year.

Mr. G. Hart-Cox, M.B.E., is shortly vacating his position at Woolwich Arsenal, to take up secretarial duties for Messrs. T. Hood & Co., Ltd., engineers, Bristol.

The Times reports that Prof. B. Mouat Jones, Professor of Chemistry in the University College of Wales at Aberystwyth, was on Monday appointed Director of the Manchester Municipal College of Technology, at £1,500 a year, in succession to Mr. J. C. Maxwell Garnett, now organiser for the League of Nations Union.

Mr. F. A. Broadbent, late manager of the Portarlington Electric Light and Power Co., Ltd., has been appointed electrical engineer and manager to the Cavan Electric Light and Power Co., Ltd.

Obituary.—Mr. A. G. Fielding.—The death is reported as having occurred at the Presidency General Hospital, Calcutta, of Mr. Arthur Gordon Fielding, an electrical engineer, holding a Government appointment in India. Prior to leaving this country he was engaged at the Formby Power Station of the L. & Y. Railway.

NEW COMPANIES REGISTERED.

Vickers (France), Ltd. (173,677).—Private company. Registered March 12th. Capital, £5,000 in £1 shares. To carry on the business of manufacturers of and dealers in steel, iron, brass and metals, ship builders, shipwrights, manufacturers of ordnance, electricians, electrical engineers, &c. The first directors are: Sir Francis Barker, Lowndes House, Lowndes Place, Belgrave Square, S.W.; M. Caillard, 16, Rue de la Bienfaisance, Paris (director of Troughton and Simms, Ltd., and Société Financiers et d'Entreprises Electrique); S. V. Dardier, The Grange, Grange Road, Ealing, W.5; E. Cohn, Rahna, Wargrave, Berks.; A. Cartwright, 35, Vicarage Road, East Sheen, S.W. Sir Francis Barker, S. V. Dardier, E. Cohn and A. Cartwright are all directors of Vickers, Argentina, Ltd., and various other companies. Qualification, £200. Remuneration, £50 each per annum. Acting secretary: W. F. Sadler. Solicitors: Linklaters and Paines, 2, Bond Court, Walbrook, E.C. Registered office: Vickers House, Broadway, Westminster, S.W.

C. A. Carpenter, Ltd. (173,616).—Private company. Registered March 10th. Capital, £2,000 in £1 shares. To take over the business of an electrical, constructional and general engineer and contractor and dealer in machinery carried on by C. A. Carpenter, at 4 and 5, Mason's Avenue, Basinghall Street, E.C. The permanent directors are: C. A. Carpenter, 4-5, Mason's Avenue, Basinghall Street, E.C.2; Mrs. K. Carpenter, 4-5, Mason's Avenue, Basinghall Street, E.C.2. Solicitor: C. G. Bonser, Pancras Chambers, 90, Queen Street, E.C.

Midlands Telephone Directories, Ltd. (173,651).—Private company. Registered March 11th. Capital, £2,500 in £1 shares. To adopt an agreement with A. Howard and A. R. Tidswell for the acquisition of the rights of publishing a "Classified Commercial Telephone Directory." The permanent directors are: A. R. Tidswell, "Uplands," College Road, Epsom; A. Howard, 61, Kensington Gardens, Ilford. Qualification, £250. Remuneration, £50 each per annum. Registered office: 3, Broad Street Buildings, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Reno, Ltd. (117,987).—Return dated December 31st, 1919 (filed December 15th, 1920). Capital, £5,000 in £1 shares (1,000 preference and 4,000 ordinary). 800 preference and 4,000 ordinary shares taken up. £500 paid. £4,300 considered as paid. Mortgages and charges, nil.

Reflecto Metal Co., Ltd.—Particulars of £5,000 debentures authorised December 30th, 1920; whole amount issued; charged on company's property, present and future, including uncalled capital.

Aladdin Renew Electric Lamp Corporation, Ltd.—Particulars of £10,000 debentures authorised February 17th, 1921; present issue £5,000, charged on the company's undertaking and property, present and future, including uncalled capital.

Yorkshire (West Riding) Electric Tramways Co., Ltd. (84,167).—Return dated February 17th, 1921. Capital, £600,000 in 70,000 cumulative preference and 50,000 ordinary shares of £5 each. 46,261 preference and 40,977 ordinary shares taken up. £436,190 considered as paid. Mortgages and charges, £272,373.

Cape Electric Tramways, Ltd. (54,636).—Capital £500,000 in £1 shares. Return dated December 2nd, 1920. 491,222 shares taken up. £91,222 paid. £400,000 considered as paid. Mortgages and charges, £243,500.

City of Ely Electric Light & Power Co., Ltd. (85,444).—Return dated January 14th, 1921. Capital, £5,000 in £1 shares. 3,003 shares taken up. £300 6s. paid (being 2s. per share). Mortgages and charges, nil.

H. W. Smith & Co. (1920), Ltd.—Debenture dated February 11th, 1921, to secure £50,000 charged on the company's undertaking and property, present and future, including uncalled capital. Holders: Lloyd's Bank, Ltd.

East India Tramways Co., Ltd. (74,457).—Return dated December 22nd, 1920. Capital, £100,000 in £1 shares (15,000 preference, 35,000 ordinary and 50,000 deferred). 7,476 preference, 33,433 ordinary, and 50,000 deferred shares taken up. £7,489 paid, including £6 on 24 shares forfeited. £83,426 considered as paid. Mortgages and charges, nil.

Hindhead & District Electric Light Co., Ltd.—Issue on March 1st, 1921, of £100 debentures part of a series already registered.

Tramways, Light & Power Co., Ltd.—Particulars of £375,000 5-year secured notes authorised November 15th, 1920, and covered by trust deed dated February 14th, 1921; present issue £200,000; charged on certain shares and debentures and the company's undertaking and property, present and future, including uncalled capital. Trustees: British Trusts Association, Ltd.

Electricars, Ltd.—Debenture dated February 15th, 1921, to secure £25,000 charged on the company's undertaking and property, present and future, including uncalled capital. Holders: Kynoch, Ltd., Lion Works, Witton, Birmingham.

Westinghouse Brake & Saxby Signal Co., Ltd. (formerly Westinghouse Brake Co., Ltd.).—Particulars of £350,000 8 per cent. first mortgage debentures, authorised October 15th, 1920, and covered by trust deed dated March 2nd, 1921; whole amount issued; charged on freehold lands, buildings and hereditaments, plant, machinery, and the company's undertaking and property, present and future, including uncalled capital. Trustees: Lloyd's Bank, Ltd.

Yorkshire (Woollen District) Electric Tramways, Ltd.—Particulars of £40,000 debentures authorised February 8th, 1921; whole amount issued; charged on the company's undertaking and property, present and future, including uncalled capital.

South Metropolitan Electric Light & Power Co., Ltd.—Issue on February 23rd, 1921, of £43,866 debentures, part of a series already registered.

Ferranti, Ltd. (83,718).—Return dated December 24th, 1920. Capital, £130,000 in £1 shares (60,000 preference, 60,000 ordinary and 10,000 deferred). 53,374 preference, 60,000 ordinary and 10,000 deferred shares taken up. £123,374 considered as paid. Mortgages and charges, £123,489.

Gosport & Alverstoke Electric Lighting Co., Ltd. (82,693).—Return dated January 14th, 1921. Capital, £25,000 in £10 shares. 2,300 shares taken up. £23,000 paid. Mortgages and charges, nil.

C. H. Hare & Son, Ltd. (110,911).—Return dated December 31st, 1920. Capital, £16,000 in £1 shares (8,000 preference). All shares taken up. £1 per share called up on 8,000 preference and 502 ordinary. £8,502 paid. £7,498 considered as paid on remainder. Mortgages and charges, nil.

Edison Accumulators, Ltd.—Satisfaction in full on February 25th, 1921, of two debentures dated March 10th, 1915, and July 4th, 1916, securing all moneys due or to become due not exceeding £5,000 and £15,000 respectively.

Napier-Kimber, Ltd.—Satisfaction in full on February 21st, 1921, of debenture dated June 14th, 1920, securing £4,000, notified second and third debentures both dated March 4th, 1921, to secure £2,500 and £4,500 respectively, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: A. W. Kimber, "Chevening," The Drive, Wembley Park.

CITY NOTES.

W. T. Henley's Telegraph Works Co., Ltd.

The annual meeting was held on Friday last at the Great Eastern Hotel, E.C. Mr. George Sutton, M.I.E.E., chairman and managing director, who presided, said that the capital account remained the same as last year, the new capital not having been issued until this year. That issue was over-subscribed. They only asked for £250,000, although they took authority to issue £400,000. The reason why they did not issue the whole amount was not quite because they did not want it, but because at the time capital issues were not going very well. They might have to issue the remaining £150,000 before the close of the year—it just depended on the course of business. They were not going to increase the capital account if they could possibly avoid it, and he was hoping they would be able to get through without any more capital. Creditors showed an increase of £200,000, due to the more than abnormal advance in the business. They were bringing the reserve up to £170,000 by the addition of £20,000, £15,000 of which was taken from an old reserve account which was closed. Turning to the credit side of the account, the item of freehold land and buildings, machinery, plant, &c., had been increased by the large sum of £102,000, and they had not yet reached the end of that expenditure. The additions were buildings and plant and new factories which had been in course of erection for the past two or three years. Some of them were started at the beginning of the war, and had to be stopped until the war was over. Difficulties with regard to material and labour had delayed the erection of those buildings, one of which ought to have been completed some months ago. They would have to spend another £80,000 to complete their projects in that direction. With regard to their investments, they had gone down, because they had been selling them, as they wanted the money. They had sold them at a very considerable loss, and £35,000 had had to be written off. They had made a further reserve of £7,500 to meet the fall in the price of the National War Bonds which they still held. As to the Henley's Tyre and Rubber Co., the capital of that concern had been increased during the year from £140,000 to £200,000, and it had since been increased by a further £50,000. The turnover of the company to the end of September, when the financial year closed, was a record one. At the present time, in common with the whole of the motor industry, they had a slackness of trade. The stocks at September 30th were taken at the very lowest figure—lower than they cost, for they had to write off a considerable amount to cover the fall in cotton. As to rubber, they never had more than a few weeks' supply in hand. The Tyre Co. had made a very great reputation for the quality of both pneumatic and solid band tires for commercial vehicles, and the latter trade continued to expand—it was only the sale of pneumatic tires that had fallen off. He could only say that he had no reason to modify the hopes which he had expressed in the past with regard to that company—they looked forward to a big future for it. Reverting to the Telegraph Works Co., the stock stood at £700,000, against £457,000 a year ago, although the price of raw materials was considerably lower. The rise in the stock was due to two causes. The first was the need that existed for increasing their stocks at all their branches at home and abroad, which had been depleted during the war. The second and principal cause was the large amount of unmanufactured orders on the books, so that in reality the larger amount of the stock was already sold as soon as its manufacture was complete. The stock was all good. It was priced at the lowest price at December 31st, whether that was the purchase price or the market price, but further than that, in years past they had provided for the eventuality that happened during the last six months—a slump in trade and a fall in prices; and they had built up a considerable reserve on the stock account. That reserve had paid income tax and excess profits duty, so that beyond the lowest price at which they had put the stock, they had a large reserve to meet the eventuality of its falling still further. So far he was glad to say they had not had to encroach upon that reserve. The debtors showed an increase of £200,000, due to the increased trade they had been doing and to some extent to the longer credit that was being taken. Turning to the profit and loss account, they had provided £35,000 for depreciation. The balance of the trading account showed £240,000, as against £203,000 a year ago, and the balance carried to the profit and loss general account was £193,000, against £168,000. It should be remembered in making a comparison that in 1920 they had had to pay 50 per cent. more in excess profits duty than in 1919, and there was also the three years' average in the income tax to be taken into consideration, so that on the whole, he thought, the shareholders would consider that the directors had put very fine accounts before them. They had had a splendid year. He did not think they had ever experienced such a difficult and anxious year with regard to the business. At times there were plenty of orders to be obtained. Sometimes they could not keep pace with the orders, but owing to the prices of raw materials, it had needed all the skill of their buyers and the management to avoid disaster. The principal raw materials in their business were copper, indiarubber, lead, and cotton. During the year copper fell from £115 to £71 per ton; lead went from £45 to £23; rubber fell from 2s. 10d. per lb. to 10d., and American cotton from 30d. to 10d. They must, of course, buy forward to meet their future requirements, and it would be apparent from those figures how carefully and successfully their buying had been done. The sale of their products, including their overseas trade, had continued to extend. The turnover for the year was the largest in the history of the company, and the orders carried forward into 1921 also constituted a record. The tendency of recent years had been for the percentage of profit upon their goods to decrease and for the turnover to increase, so yielding to the shareholders a larger profit. If the turnover should decrease, it might be that the rate of profit would go up. They had done a great deal of telephone work—in fact that had been one of the busiest departments of the business. They had supplied telephone trunk cables both for their own Post Office and for foreign countries. They had a long continuously loaded telephone cable which they shipped only this month to be laid across the Straits of Georgia, British Columbia. Another order of interest was that with which they had been entrusted by the city of Birmingham for an e.h.p. cable to work at 33,000 volts—at the time it was placed it was

the largest order that had ever been placed of its kind. The contract for that work was nearly completed. Their general trade had gone into all countries. Jerusalem had become a buyer of their cables, and to-day the name of the company was well known in Bagdad and Mesopotamia. With regard to the current year, they had no abnormal anxiety as to the payment of dividends, but that was not the sole object of the company. Dividends were, of course, essential for its continuance, but they absorbed a comparatively small part of the profits earned. A large portion of the profits had been used for the development of the industry at home and abroad, and for the increase of employment. A large export trade was, they knew, essential to the nation, and it was for them as well as others to do their part to create and maintain such a trade. British cable manufacturers generally had hitherto held a record for trade throughout the world which had been held by no other country, and to-day their record for quality of work, for design and manufacture of cables, and for the method of doing their business was unimpaired, but with regard to their sales to foreign countries the red danger light had been showing for months, and whereas up to the middle of last year they could get more orders for foreign countries than they could take, to-day there were hardly any foreign orders coming in to their office. He was not referring to the dominions overseas, but to foreign countries. There were several causes for that condition of things; perhaps the most important was that they were unable to compete in price with the foreigner. How could they compete with Germany, when wages in England were three or four times higher than they were in the German cable factories? They did not like the idea of reducing wages—they might not have to do it; they could certainly earn dividends without doing so, but they wanted to increase employment in their factories, and that could not be done unless they could reduce their prices to meet their foreign competitors. He firmly believed that the rates of wages paid to their workmen at the present time would have to come down, and a good standard of living must be secured to them by longer working hours. To put it in another way, they must have a larger output for their wages, if they were going to keep their foreign trade. War bonuses were given to the workmen and to the commercial staff. In the case of the latter, they decreased with the cost of living, and it seemed to him that the workmen in the factories should be subject to the same procedure. The standard of living must and would be better in the future than it was pre-war, but it must be obtained by mechanical and human devices to improve the output per worker.

Mr. Martin Roberts, M.Inst.C.E., seconded the motion for the adoption of the report and accounts, which, after a brief discussion, was carried unanimously.

Automatic Telephone Manufacturing Co., Ltd.

The profit for 1920 was £15,370, plus £9,341 brought forward. Directors' fees are £2,850; depreciation on patents, goodwill, buildings, plant and machinery, £3,000; preference dividend £12,000. The report reads: "Our activities during the past year have been chiefly devoted to the special measures necessary to give effect to the terms of our agreement with the International Automatic Telephone Co., Ltd., for the promotion of overseas sales of Strowger automatic telephone apparatus. Orders of considerable value have resulted from this alliance, and to cope with these, extensive additions to personnel have been necessitated. The staff of our engineering and drafting departments has been largely increased, and new departments—essential to bulk production—created, involving establishment and development expenses on an abnormal scale. The development work accomplished can, however, be regarded as fundamental and should be beneficially reflected in our future activities. Much productive work has been accomplished against automatic telephone contracts, but the manufacturing period under review was too limited to enable any appreciable volume of this work to be converted into sales. For this reason, coupled with the heavy development expenses referred to, the directors regret that the profits for the year will not allow of any dividend being paid on the ordinary shares."

Brompton and Kensington Electric Supply Co., Ltd.

In the course of his speech at the annual meeting of this company, the chairman said they had secured record results; notwithstanding the difficult times, they compared favourably with the results of any year in their history. The conversion of the larger houses into flats and maisonettes continued, and the demand for cooking and domestic accessories increased, so that they had again not only connected more consumers and made more lamp connections, but had also sold more electricity than in any previous twelve months, and this notwithstanding the extension of daylight saving by a month, and the higher price which they had had to charge to cover the great increase in the cost of coal. The consequence of the coal strike last year was to compel them to pay an average of 11s. 4d. per ton more for coal of a greatly inferior quality, and but for their improved working conditions, which resulted in a smaller coal consumption per unit generated, the coal bill for their increased output would have been much greater than it was. The year before last, when coal cost them 31s. per ton, their coal cost per unit generated was .806d., whereas last year, when coal cost 42s. 6d. a ton, their coal cost per unit was only .97d., so that although the coal cost had gone up 36 per cent., their coal cost per unit generated had only gone up 20 per cent. This economy in production, due to the progress of invention, would continue, and they were this year installing, with the assent of the Electricity Commissioners, another large turbo-alternator of improved design. The gross receipts last year were £102,372, as against £74,045 in 1919, and the working expenses £59,469, as against £44,683, so that the net receipts were £42,902, as against £29,361, or an increase of £13,541, which would enable them to pay the same dividend as last year, after making larger provision for depreciation and reserve. They had written off about £7,000 worth of machinery from the station which had become obsolete for their purpose, and they had spent an additional £5,000 on their mains system, which in weight of copper and carrying capacity, if they should require to raise their declared pressure, was worth to-day at least the whole of the original capital of the company. They had made further advances to the Accessories Co., which were justified by the results of its working. Its assets continued to be worth their book value, it constituted one of their best customers, and its work contributed effectively to the business of supply in their area. In spite of the unsettlement of the electricity supply of London by well-intentioned, but ill-advised, political action, the prospects of the company for the current year were satisfactory.

Notting Hill Electric Lighting Co., Ltd.

At the annual meeting, on March 15th, Mr. A. Hoare, who presided, expressed the view that the Government of this country was interfering a great deal too much with private affairs. Nearly the whole of the company's new capital expenditure during 1920 was incurred in laying new mains and purchasing new meters to connect additional consumers. The provision of further capital would receive consideration in the near future if they were to extend the business. The fact that their undertaking was purchasable by the authorities in 1931, coupled with doubts regarding the interpretation of the terms of purchase, made it difficult to issue new capital at any reasonable rate. The profits rose from £31,200 to £33,800 in spite of heavy increases in the cost of production. Though the revenue from sale of energy was up nearly £19,000, the profit was only £2,600 above that of 1919. The speaker later referred to the new Electricity Supply Bill. Under its provisions, he said, a scheme promoted by some of the London companies in conjunction with the L.C.C. and local authorities, was in preparation for submission to the Electricity Commissioners for the establishment of a Joint Authority for the supply of energy within the London and Home Counties' Electricity District, the boundaries of which had been settled by the Commissioners. The only details of the scheme available at present were rough outlines of the engineering side, and no information was yet to hand of the proposed arrangements to finance the scheme. The company had not, up to the present, joined in supporting the proposal, but, when full details could be obtained, the whole matter would receive careful consideration. It would be a very difficult problem in the present state of the finances of the country to obtain a very heavy amount of capital which would be necessary to finance a scheme of this magnitude. With regard to the future, the business for the current year showed improvement, and as, recently, they were able to come to a satisfactory agreement with the unions representing the workmen throughout the industry in the London area, regulating wages by agreement over a long period, they hoped it would prevent difficulties arising in this direction. Regarding the joint works at Wood Lane, the cost of generating electricity rose considerably, and was due not only to increased wages, but to the higher cost of fuel. To some extent they were endeavouring to counteract this rise in coal cost by the installation of new and more economical plant. One set had already been erected, and two others were in hand.

Pinchin, Johnson & Co., Ltd.

The annual meeting was held at General Buildings, Aldwych, London, on Monday. Mr. E. Robson, who presided, referred to the very satisfactory results of the year's trading, in spite of the difficult trading conditions that had developed in the latter months of the year. After providing for all expenses, depreciation, income tax, excess profits, and Corporation profits tax, there was a net profit of £72,282, plus £4,642 brought forward. After paying 6½ per cent. for the year on the preference shares, a final dividend of 10 per cent. actual on the ordinary shares was recommended, making, with the interim dividend of 5 per cent., 15 per cent. for the year, less income tax. There was £10,000 put to reserve, £8,500 written off preliminary expenses of new capital issue, and £10,588 remained to carry forward. Doing a very extensive business, such as they were, it was necessary to carry extensive stocks, and although on some commitments there had been fairly substantial depreciation in the latter months of the year, the directors had adopted the sound course of writing down the trading stocks to current market prices at December 31st, 1920, which placed their business in a very strong position to withstand what remained of the present trade depression. During the year the company had extended its operations in every market of the world, and in output, volume of sales and net profits the results constituted a record. Arrangements had been completed for substantially increasing the production at their several factories, and they were able to deal efficiently with a much greater volume of business than

ever before. Their sales organisation had also been consolidated and extended in every direction. Although the trade slump, which had become evident in the latter months of 1920 was still felt to some extent, he had every confidence that 1921 would be a satisfactory year.

Chelsea Electricity Supply Co., Ltd.

At the annual meeting, on March 16th, the chairman said it was a good many years since they had been able to present such satisfactory accounts. In common with those of all the London companies, their figures showed a very noticeable improvement, as compared with 1919. The amount carried to net revenue was £41,874, as against £33,038 in the previous year, an increase of 26 per cent. This enabled them to recommend a dividend of 6 per cent. for the year, as against 4 per cent. for 1919. The year's results had been achieved notwithstanding increased costs of as much as £14,000, the principal increases being for coal and energy purchased, £5,194; salaries and wages, £2,910; rates, £2,686; and repairs to buildings and machinery, £2,737. The enormous increase in rates was the cause of much anxiety to all industrial undertakings, and increases beyond what appeared in their accounts were to be feared. Fortunately the Councils which governed local matters in their area of supply were not of the socialist order. Ratepayers all over the country were being aroused to a sense of the danger of rising rates. During the year they dismantled the Cheyne Walk station containing their oldest plant, which, although useable, was the reverse of economical. The recent settlement as to wages concluded under the auspices of the District Council No. 10, which was formed to promote agreement as to wages in the London area, was working satisfactorily for the present. They might look forward with confidence to the future if they could hope to be let alone to work out their own salvation. Schemes for consolidating the electricity supply of London, however, involving enormous capital outlay were proposed. Most of the companies had come together for the purpose of safeguarding their shareholders' interests, and their chairmen were in constant consultation. It was difficult to say what the outcome would be, and in the meantime all the directors could do was to wait and watch, and do all in their power to secure fair and reasonable treatment.

Davis and Timmins, Ltd.

Sir Henry C. Mance, presiding at the annual meeting, on March 15th, said that the item "Sundry debtors" was rather higher, but this, he thought, would be found the case with every manufacturing company, owing to the shortage of money, brought about by the difficult conditions in certain trades and the disinclination on the part of the directors to press unduly their customers. Stock was higher, due to the fact that they had found it advantageous to themselves and a great convenience to their customers to keep a larger stock of manufactured articles. It included, also, an increased amount of metal. Trade expenses had advanced, mainly in consequence of the increased costs in every department. Salaries were higher in consequence of various well-deserved promotions. Bad debts were higher, but this, he thought, was a state of things common to every company having such a multitude of accounts. Notwithstanding the increased charges, the net profits had increased by nearly £800. As regarded the future, although he did not share the pessimistic views of many writers, they should not ignore the fact that a good deal of uneasiness existed in certain quarters. Last week he had had occasion to place a substantial order with one of the largest manufacturing firms in the country. Delivery was promised in six weeks. He was quite sure that if that order had been given a year ago the time for delivery would have been six months. It might take some time before they got back to normal prices and normal trade.

Mr. G. E. Davis (managing director) said that since the last meeting they had added a large new building, and were now in possession of a splendidly equipped inspection department. When business revived, which it must do sooner or later, they would be in a better position, and better equipped than they had ever been, to deal with it.

City of London Electric Lighting Co., Ltd.

The ordinary general meeting of the company was held on March 16th, when Mr. J. B. Braithwaite took the chair. Reviewing the financial results, the chairman said that the year's revenue showed an increase of £128,275, but owing to the increased cost of labour, coal, and materials, the net result was only a profit of £31,266. The chairman then dealt at some length with the present position of electricity supply in London, and said that any attempt to amalgamate the municipal with the company undertakings presented great difficulties, owing to the different bases of tenure. In the speaker's opinion, the simplest way of unifying the electricity supply would have been to grant the companies a considerable extension of tenure which would have justified them in making the large expenditure necessary to correct existing anomalies. A step in this direction had been taken by the passing of the Electric Lighting Act of 1908, which substituted the L.C.C. as the sole purchasing authority, and empowered companies and local authorities to link up their stations. Great progress had been made in this direction. Referring to the Electricity (Supply) Act of 1919, the chairman said that one result had been the holding up of development and the erection of the big station at Barking had been effectually blocked. Dealing with the position of the company, he said that they had laid an interconnector between their station at Bankside and the County of London Electric Co.'s station at Wandsworth, which would enable them to give that company 10,000 kW in bulk. The present capacity of their plant at Bankside was 33,500 kW, and they hoped to have a further 20,000 kW installed in the autumn, of which 10,000 would be given to the County of London Co., leaving them 10,000 to meet their own increased demand. The Bankside station must play an important part in the future electric supply of London, as it occupied a central position and had unlimited supplies of condensing water and every facility for the delivery of coal. Its ultimate capacity was about 80,000 kW, and it could supply in bulk the inner ring of the London area more economically than could be done by any station further away. The directors quite anticipated that it would be in operation in time for the revenue to benefit in the last quarter of the present year. The company had not raised any additional capital since 1900, having paid for all the new plant, extensions, and mains, &c., out of revenue, but the large additions to their generating plant which they were now making would oblige them to raise a small amount of additional capital, and they proposed to issue £300,000 of the £800,000 capital, which they still had available, in the form of 8 per cent. cumulative second preference shares. The issue would be made shortly after Easter, and the shareholders would have preferential consideration. Taking the figures for last year, the margin of profit would cover the interest on that issue more than ten times, so that the security would be an excellent one, and should prove attractive. The report and accounts were adopted, and a resolution increasing the borrowing powers of the company was passed.

County of London Electric Supply Co., Ltd.

The twenty-seventh ordinary general meeting was held on March 15th, Sir Harry Renwick, K.B.E. (chairman), presiding. The chairman, in moving the adoption of the directors' report and accounts, said that the total receipts from sales and meter rentals had risen by 24 per cent. to £674,105. Working expenses had risen by about 27 per cent., and an explanation of this was to be found in the higher cost of coal, higher salaries and wages, and the ruinously high rates and taxes. As to coal, the fuel costs were about 32 per cent. of the total generating costs for the year. Coal had cost on the average 7s. 4d. per ton more than in the previous year, the average cost now being three and a half times the pre-war cost, and for inferior quality. Salaries and wages were some 20 per cent. above the 1919 level. The costs of repairs were exceptionally heavy; this was partly due to an accumulation of repairs deferred during the war period, and partly to the rise in cost of materials and wages. Rates and taxes had increased by £12,303, largely owing to the alarming increase in local and municipal rates. To the speaker's mind the question of municipal expenditure and local rates was one of the most pressing questions of the hour, the importance of which was not fully realised by the public. It appeared hitherto to have escaped the criticism it would otherwise have attracted and to be overshadowed by the bigger question of national expenditure, but at last there were signs of an awakening on the part of the public, and there were many who felt as he did that it was time steps were taken to put a stop to municipal extravagance, which was as vicious and baneful in its effects as national extravagance. Dealing with the progress of the company, the chairman said there was a record increase of over 7,000,000 units sold, which reached the respectable total of nearly 50,000,000 units in the year, while applications for new business showed a net increase of 5,678 kW. They had now connected to their mains nearly 90,000 kW, while they were supplying over 35,000 consumers. This indicated in a telling way the continued vitality of the company's business and the potentialities and possibilities of the future, which, having regard to the company's extensive areas, were practically unlimited. As to the prospects for the current year, with so many uncertain factors, it would serve no useful purpose to attempt a definite forecast, but, broadly, he thought he could speak reassuringly as to the progress of business, and he had every confidence that, barring any really big eventuality, the results for the current year should continue to be satisfactory. As to future rates of pay and costs of living, the position was altogether artificial, but in spite of the Government and its policy of political expediency, wages were bound to come down through economic pressure and the dire necessities of the situation, which would be all to the good for the shareholder, for the worker, and for the country at large in the current year. They had done everything that could be done to place the company in a strong position, and they were, therefore, fully justified in looking forward to the future with every confidence.

German Companies.

The accounts of the *Bergmann Elektrizitats Unternehmungen A.G.*, of Berlin, show profits of 40,000 marks for 1919-20, as against 204,000 marks in the previous year on a paid-up capital of 6,000,000 marks. The company has hitherto not paid any dividend.

The accounts of the *Electrochemische Werke*, of Bitterfeld, for 1920, after writing off 4,500,000 marks for depreciation as against 2,100,000 marks in 1919, show net profits of 1,940,000 marks, as contrasted with 2,629,000 marks in the previous year. It is proposed to pay a dividend at the rate of 15 per cent. on

share capital of 12,000,000 marks, being the same rate as in 1919, when the participating capital was less.

The report of the *Telephonfabrik A.G. vorm. J. Berliner*, of Hanover, states that notwithstanding the great difficulties in obtaining raw materials and the uncertainty of manufacturing owing to the frequent strikes, it was possible to realise satisfactory results in 1919-20. The net profits were 1,535,000 marks, as compared with 678,000 marks in 1918-19, and the dividend is at the rate of 15 per cent., as against 6 per cent. in the preceding year. It is mentioned that the company's works at Vienna has been transferred to a company entitled the Austrian Telephone Co., with a share capital of 15,000,000 kronen, of which one half is held by Austrian interests.

Rhondda Tramways Co., Ltd.—According to the "Financial Times," it is proposed to convert the 6 per cent. cumulative preference shares of the Rhondda Tramways Co. into 8 per cent. non-cumulative participating preference shares with a 25 per cent. participation in the surplus divisible profits, the arrears of dividend being waived as consideration for the suggested alteration. In the course of a circular to shareholders of the Rhondda Tramways Construction Syndicate (in liquidation) the joint liquidators, Messrs. L. B. Schlesinger and W. B. Cownie, state: "We have no doubt that the conversion would be of considerable advantage to the shareholders, inasmuch as upon a distribution of securities they would receive a more marketable security."

Isle of Thanet Electric Tramways & Lighting Co., Ltd.—For the year ended September 30th last the traffic receipts, including omnibuses, were £74,110, and from sale of electricity £22,626, the total receipts from 1920 being £97,244, against £66,394 for 1918-19, and the balance carried to appropriation account of £32,144, against £30,553. The sum available is £24,797; to reserve, £2,500 (increasing it to £15,000); to permanent way reserve, £10,000 (making it £30,000); to rolling stock reserve, £7,500 (making it £15,500); forward, £4,285. The directors (according to the *Financial News*) look forward to the resumption of a dividend on the preference shares for the year to September 30th, 1921.

Clyde Valley Electrical Power Co.—For the year 1920 the balance of profit was £149,392, plus £58,302 brought forward. The preference dividend absorbs £18,000; a total of 7½ per cent. for the year on the ordinary shares requires £45,000; there is put to contingency fund £75,000; carried forward £69,693. The 15,000-kW turbo-alternator installed at Yoker power station has been running on commercial load since March last. The installation of the 15,000-kW turbo-alternator at Clyde's Mill power station has been considerably delayed, but it is expected that the plant will be in operation in June. Mr. J. K. Stothert has resigned from the board; Dr. R. T. Moore has been elected in his place.

Companies to be struck off the Register.—The following companies are to be struck of the register unless cause is shown to the contrary within three months:—

A. B. Vibro & Domestic Electrics, Ltd.
Feltham & District Electric Lighting Co., Ltd.
Non-conductors, Ltd.
Snyder Electric Furnace Co., Ltd.
Wholesale Battery Co., Ltd.

American Telephone and Telegraph Co.—Earnings for 1920, after meeting all operating charges and providing for depreciation and obsolescence and for Federal taxes payable in 1921, totalled $70,686,904. Interest charges were $18,865,688. Dividends paid at usual rate of $8.00 per share per year amounted to $35,376,792, appropriated for contingencies $8,000,000, leaving $8,444,422 carried to surplus account. During the year investments in associated companies increased $33,653,891.—*Financial Times.*

Bullers, Ltd.—The accounts for year ended July 31st, 1920, show, after paying directors' fees and salaries, and providing for E.P.D. and corporation tax, a profit of £23,353, plus £846 brought forward. Owing to present financial stringency and necessity for conserving resources, says the *Financial Times*, the directors propose to carry forward balance of £8,949 remaining, after payment of 5 per cent. dividend on ordinary shares in November, 1920.

Denmark.—Aktieselskabet Nordiske Kabel-og Traadfabriker realised during 1920 a net profit of 2,720,000 kr: Out of this sum over 1,200,000 kr. is devoted to writing down of machinery, &c., 133,000 kr. is placed to reserve, and the directors propose to pay a dividend of 12 per cent., carrying forward 11,000 kr.—*Reuter's Trade Service* (Copenhagen).

Salisbury Electric Light & Supply Co., Ltd.—The profit balance for 1920 was £7,531, against £5,733 for 1919. Interest on debentures requires £742, and depreciation of investments £249. £3,095 is brought forward, and the balance is £9,634. The dividend for the year is 7 per cent; £3,000 is put to depreciation and reserve fund; and £4,184 is carried forward subject to E.P.D.

International Automatic Telephone Co.—A financial contemporary states that the profit for the ten months ended December 31st, 1920, was £11,778; dividend on preference shares £11,136; carried forward £633. Profits will not allow of dividend on ordinary and deferred shares.

Hadfields, Ltd.—Further dividend of 6d. per share on the ordinary shares, making 5 per cent. for the year, free of tax.

Belgium.—The report of the Société d'Electricité de l'Escaut, of Antwerp, for the last financial year shows a profit of 1,086,652 fr., as compared with only 187,702 fr. in 1919.

Globe Telegraph & Trust Co., Ltd.—Quarterly interim dividend of 3s. per share on preference shares, less tax; 5s. per share on old and new ordinary shares (tax already deducted); 4s. 8d. per share, being interest at rate of 10 per cent., tax free, in respect of instalments paid on new ordinary shares.—*Financial Times.*

South London Electric Supply Corporation, Ltd.—A dividend of 9 per cent. per annum is announced on the ordinary shares for the last half of 1920, making 7 per cent. for the year. £5,769 carried forward.

Robey & Co., Ltd.—Dividend of 2½ per cent., less tax, on the preference and ordinary shares. Carried forward £27,995, subject to E.P.D. and corporation tax.

Sir W. G. Armstrong, Whitworth & Co., Ltd.—Dividend on ordinary shares for half-year ended December of 1s. per share, making 2s. per share for the year 1920, less tax.

Wemyss & District Tramways Co., Ltd.—Final dividend of 6 per cent., free of tax, on the ordinary shares.

Shawinigan Water & Power Co.—Dividend of 1¾ per cent. on common stock for the quarter.

STOCKS AND SHARES

Monday Evening.

The main interest in the Stock Exchange centres upon the movements in gilt-edged securities. These are held, naturally enough, to reflect the possibilities with regard to cheaper money. Some hoped that there would be a reduction in the Bank Rate before the Easter holidays, but other quarters—and those probably better informed—look for no relief until Budget time. The remarkable rises that occurred in the War Loan and other stocks of this sort gave way a little, on sales evidently of the profit-taking order. There is, however, an atmosphere of cheerfulness, and the Stock Exchange looks forward (as it has done for the last many decades) to an improvement in business "after Easter."

Several important issues are pending in the electricity supply world. Amongst these one of the first comers will certainly be the 300,000 City of London Electric 8 per cent. second preference shares. The prospectus indeed may be out this week. Later, there may be expected an issue of about half-a-million pounds in Central Electric 8 per cent. Notes. It is said that these will be offered in the neighbourhood of 97. With the guarantees which the Central Electric commands, the terms certainly look tempting, so far as can be surmised without the necessary details. The Metropolitan Electric Supply Co. is another which will probably be in the field before long with a debenture issue.

With the prospect of these newcomers appearing in the early future, it is natural that prices in the electrical market should be quiet, as might be the case, anyway, at this season of the year. There is Summer-time just ahead, and rightly or wrongly, the investor seems to think that this has an unfavourable effect upon illumination shares. Nevertheless, Westminster ordinary have stiffened to £5 and Metropolitan ordinary to 3. City of London preference are better at 18s.

Interest will watch with attention whether the Metropolitan Company, if it makes a new debenture stock issue, will invite co-operation from London firms in connection with the underwriting.

Metropolitan Railway ordinary stock is better at 22, and Underground Incomes have hardened to 66½. The market in steam stocks is hesitating. How the railwaymen and the miners will take the automatic reduction in wages, which should come about in the course of the next ten days, is a matter upon which investors feel a trace of dubiety. This, however, has not affected iron, steel and similar shares. Babcock & Wilcox keep good at 2⅞.

British Aluminium have recovered sharply to 17s. 6d. Callender's are 1/16 up at 1 7/16. Henley's keep a good market at 1⅞. The cable manufacturing companies are doing well, and the chairman of Henley's at the meeting the other day spoke of the good results which his company is achieving with its golf balls. The impoverished golfer may be moved to wonder why, with rubber at 1s. a lb., some enterprising manufacturer does not reduce the present 3s. ball to a price more suited to the aforesaid golfer's pocket. Telegraph Constructions are better at 20½. General Electrics improved to 23s., although the preference eased off to 18s. The market in electrical manufacturing shares as a whole is quiescent. That the past year is bound to have turned out a bad one from the point of view of profits is now generally acknowledged, and the protracted fall in prices has discounted to some extent whatever unfavourable reports there may be to come.

Mexican issues are weaker, both the Mexican Light & Power and the Mexico Tramways bonds going back owing to the scarcity of news from the country. Vera Cruz shares are 2s. up at 17s. 6d. No changes have occurred in the Argentine, Brazilian or British Columbian groups.

The telegraph and telephone list is firm, with Eastern

Extensions up to 16 again. Cuba Submarine ordinary are a little better at 6½. Marconi's advanced to 38s. 9d. The International Automatic Telephone Company issues its report and balance-sheet for the ten months ended December 31st, 1920. The profits amount to £11,778, of which all but £640 is absorbed by the preference dividend. The company carries forward the balance, with an expression of regret from the directors that the profit for the period covered by the accounts will not allow of a dividend being paid on the ordinary or deferred shares. Of these it may be remarked that there are 208,570 ordinary shares issued and 360,000 deferred, all of £1 each fully paid. Good people in America, we observe, seem to be very much annoyed at the proposal to advance their telephone rates by 28 per cent.

The rubber share market is not bad, in spite of the flatness of the raw stuff. There is, of course, no business worth mentioning. Sellers are conspicuously absent, and there are a few buyers who take the longer view in regard to the future of the rubber industry, and are laying in small parcels of shares in the good companies at the present prices. One or two concerns, it may be observed incidentally, are having no little difficulty to raise money at this present juncture. The armament group is also better. Armstrongs provided something of a pleasant disappointment by declaring a dividend making 10 per cent. for the year, less tax, as against 12½ per cent., free of tax, a year ago. The price rose from 17s. 3d. to 18s. 3d. In view of the recent results achieved by certain kindred companies, Armstrongs are deemed to have done well, and Vickers, both ordinary and tax-free preference, hardened in sympathy to 12s. 6d. and 14s. 3d. respectively.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend 1919.	Dividend 1920.	Price March 21, 1921.	Rise or fall.	Yield p.c.
Home Electricity Companies.					
Brompton Ordinary	12	13	f½	+ ½	£9 13 0
Charing Cross Ordinary	7	8	8xd	—	10 13 4
do. do. do. 4½ Pref.	4½	4½	2⅝	—	8 8 8
Chelsea	4	6	8¾	—	9 10 6
City of London	13	14	28/-	+2d.	11 4 0
do. do. 6 per cent. Pref.	6	6	18/-	+6d.	6 13 4
County of London	8	8	7½	—	10 6 6
do. do. 6 per cent. Pref.	6	6	8½	—	7 5 5
Kensington Ordinary	7	9	4	—	11 5 0
London Electric	2½	2½	1	—	7 10 0
do. do. 6 per cent. Pref.	6	6	2¼	—	10 18 2
Metropolitan	6	7	8	+ ½	11 13 4
do. 4½ per cent. Pref.	4½	4½	2½	—	8 16 8
St. James' and Pall Mall	13	13	6	—	10 0 0
South London	6	—	2⅜	—	9 2 10
South Metropolitan Pref.	7	7	15/9	—	8 17 10
Westminster Ordinary	10	10	5	+ ½	10 0 0
Telegraphs and Telephones.	1918	1919			
Anglo-Am. Tel. Pref.	6	6	83½	—	7 9 3
do. Def.	33/6	1½	16	—	9 7 6
Chile Telephone	6	6	5½	—	*5 6 9
Cuba Sub. Ord.	7	7	6¾	+ ¼	*10 15 4
Eastern Extension	10	10	15	+ ½	6 5 0
Eastern Tel. Ord.	8	10	160½	—	*6 4 7
Globe Tel. and T. Ord.	8	10	15½xd	—	6 8 0
do. do. Pref.	6	6	9xd	—	6 13 4
Great Northern Tel.	22	22	30½	—	10 14 6
Indo-European	13	10	80	—	8 6 8
Marconi	25	25	1¼	+ ⅛	—
Oriental Telephone Ord.	10	12	2⅝	—	*5 9 7
United R. Plate Tel.	8	8	6¼	—	*6 10 8
West India and Panama	1/8	Nil	⅛	—	Nil
Western Telegraph	8	10	15	—	*6 5 0
Home Rails.	1919	1920			
Central London Ord. Assented	4	4	43½	—	9 4 6
Mesropolitan	1½	1½	23	+1	6 16 4
do. District	Nil	Nil	13½	—	Nil
Underground Electric Ordinary	Nil	Nil	1½	—	Nil
do. do. "A"	Nil	Nil	5/-	—	Nil
do. do. Income	4	2	66	+1	3 0 2
Foreign Trams, &c.	1918	1919			
Anglo-Arg. Trams, First Pref.	Nil	5½	2¾	—	10 9 6
do. do. 2nd Pref.	Nil	Nil	8½	—	Nil
do. do. 5 % Deb.	5	5	59½	—	8 8 0
Brazil Tractions	Nil	Nil	37	—	Nil
British Columbia Elec. Ry. Pfds.	5	5	56	—	8 18 6
do. do. Preferred	3½	5	64½	—	*8 14 0
do. do. Deferred	Nil	3	51½	—	*11 17 6
do. do. Deb.	4½	4½	64½	—	7 11 8
Mexico Trams 5 per cent. Bonds	Nil	Nil	37	-2	Nil
do. 6 per cent. Bonds	Nil	Nil	21½	—2	Nil
Mexican Light Common	Nil	Nil	12½	—	Nil
do. Pref.	Nil	Nil	18	—	Nil
do. 1st Bonds	Nil	Nil	59	—2	Nil
Manufacturing Companies.					
Babcock & Wilcox	15	15	21	—	*6 6 4
British Aluminium Ord.	10	10	17/6	+1/9	11 8 6
British Insulated Ord.	12½	15	15	—	10 0 0
Callenders	25	15	11⅛	+ ⅛	10 18 2
,, 6½ Pref.	6½	6½	17/6	—	7 8 7
Castner Kellner	20	17	2⅞	—	7 12 9
Crompton Ord.	10	10	18/9	—	14 11 6
Edison-Swan	10	10	10/-	—	—
do. do. 5 per cent. Deb.	5	5	70	—	7 2 10
Electric Construction	10	10	15/9	—	12 14 6
English Electric	—	8	11/-	—	14 11 0
Do. Pref.	—	6	13/6	—	8 17 10
Gen. Elec. Ord.	6½	6½	18/-	—6d.	7 4 5
do. Ord.	10	10	28/-	+6d.	*8 13 10
Henley	25	15	1¾	—	10 18 2
do. 4½ Pref.	4½	4½	5½	—	6 18 6
India-Rubber	10	10	1	—	—
Met.-Vickers Pref.	—	3	18	—	9 17 0
Siemens Ord.	10	10	20/6	—	*9 15 2
Telegraph Con.	20	20	29½xd	+ ½	*5 16 8

* Dividends paid free of Income Tax.

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general and they may vary according to quantities and other circumstances.

Tuesday, March 21st

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Oxalic	per lb.	9½d.	1½d. dec.
a Ammoniac Sal	per ton	£75	..
a Ammonia, Muriate (large crystal)	,,	£65	..
a Bisulphide of Carbon	,,	...	...
a Borax	,,	£94	£1 dec.
a Copper Sulphate	,,	£35	...
a Potash, Chlorate	per lb.	6½d.	½ dec.
a ,, Perchlorate	,,	10d.	...
a Shellac	per cwt.	£15	£1 dec.
a Sulphate of Magnesia	per ton	£16	...
a Sulphur, Sublimed Flowers	,,	£20	£1 dec.
a ,, Lump	,,	£18	...
a Soda, Chlorate	per lb.	4½d.	...
a ,, Crystals	per ton	£7	...
a Sodium Bichromate, casks	per lb.	1½	...
METALS, &c.			
p Babbitt's Metal Ingots	per ton	£95 to £300	...
c Brass (rolled metal 2" to 12" basis)	per lb.	11¾d.	½d. dec.
c ,, Tubes (solid drawn)	,,	1/1½ to 1/2	...
c ,, Wire, basis	,,	1/0½	½d. dec.
c Copper Tubes (solid drawn)	,,	1/0½	...
c ,, Bars (best selected)	per ton	£114	£2 dec.
c ,, Sheet	,,	£114	£2 dec.
c ,, Rod	,,	£114	£2 dec.
d ,, (Electrolytic) Bars	,,	£71	£1 dec.
d ,, ,, Sheets	,,	£143	...
d ,, ,, Wire Rods	,,	£87	£1 dec.
d ,, ,, H.C. Wire	per lb.	11½d.	½d. dec.
f Ebonite Rod	,,	3/6	...
f ,, Sheet	,,	3/-	...
n German Silver Wire	,,	2/9	...
h Gutta-percha, fine	,,	14/- to 16/-	...
h India-rubber, Para fine	,,	11½d.	...
i Iron Pig (Cleveland Warrants)	per ton	Nom.	...
l ,, Wire, galv. No. 8, P.O. qual.	,,	£45	...
g Lead, English Pig	,,	£20 5s.	15/- inc.
g Mercury	per bot.	£12 10 to £13 15	...
e Mica (in original cases) small	per lb.	4d. to 4/-	...
e ,, ,, ,, medium	,,	5/- to 10/-	...
e ,, ,, ,, large	,,	12/6 to 35/- & up	...
p Phosphor Bronze, plain castings	,,	1/4 to 1/9	...
p ,, ,, rolled bars and rods	,,	2/1 to 2/6	1d. to 2d. dec.
p ,, ,, rolled strip & sheet	,,	2/3 to 2/7	1d. to 2d. dec.
d Silicium Bronze Wire	per lb.	1/4	...
r Steel, Magnet, in bars	,,	1/6	...
n Tin, Block (English)	per ton	£153 to £154	£5 to £3 inc.
n ,, Wire, Nos. 1 to 16	per lb.	4/-	6d. dec.
p White Anti-friction Metals	per ton	£76 to £300	...

Quotations supplied by—

a G. Boor & Co.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakespeare.
h Edward Till & Co.
i Bolling & Lowe.
l Richard Johnson & Nephew, Ltd
n P. Ormiston & Sons.
p ———
r W. F. Dennis & Co.

Aircraft Lights.—To assist in the successful development of night-flying facilities for aircraft, experiments have been carried out at the Government terminal aerodrome at Croydon and along the route to the Channel coast with various types of aerial lighthouses, searchlights, pyrotechnic lights, and obstruction and landing lights. In order that those different forms may be tested by observation from the air, it has been arranged that the civil airship G.F.A.A.G. (late H M. Airship R 33), which is now carrying out mooring-mast experiments at Pulham airship station, will undertake an observational flight along the London-Folkestone route. The observational flight will be carried out on the first suitable occasion. The ship will leave the mast at Pulham shortly after dusk, will proceed over London to the neighbourhood of Croydon aerodrome, and will test the range and efficiency of the aerial lighthouse and searchlights from the point of view of easy location of aerodromes. Observers will also decide on the value of certain pyrotechnic aids to navigation and examine the obstruction lights, and, if they are completed, the illuminated landing "L's" which are being fitted to provide a semi-automatic indication to aeroplane pilots of the direction and position in which they should land and take off. Observation will also be made of a new "Cone" light which is being experimented with as a local pilotage light at aerodromes. This light is projected downwards on to a white cone, and, if found to be satisfactory, will be used as the main location light at civil aerodromes, the aerial lighthouse proper being reserved for marking intermediate points on routes. From Croydon the airship will proceed along the London-Continental route to Lympne, where she will survey from the air a spot that has been tentatively selected for an aerial lighthouse. For observation purposes a small war-time lighthouse has been temporarily erected on the spot. The ship will then pass over the coastline, and will carry out observations of various types of marine lighthouses and light-vessels in the Channel and the North Sea which are visible from the air. During the flight, wireless practice for direction-finding purposes will be carried out, and general wireless telegraph and telephone communication will be maintained with land stations.

THE INFLUENCE OF TRANSFORMER CONNECTIONS ON THIRD HARMONIC VOLTAGES & CURRENTS.

By S. AUSTEN STIGANT, A.M.I.E.E., M.Am.I.E.E.

(*Concluded from page 361.*)

Objectionable Features of Third Harmonics.

These naturally come under two headings: (1) due to third harmonic currents; (2) due to third harmonic voltages, and they may be summarised as follows:—

1. *Due to third harmonic currents.*

(*a*) Overheating of transformer windings and of load.

(*b*) Telephone and discriminative protective gear magnetic disturbances.

(*c*) Increased iron loss in transformers.

2. *Due to third harmonic voltages.*

(*a*) Increased transformer insulation stresses.

(*b*) Electrostatic charging of adjacent lines and telephone cables.

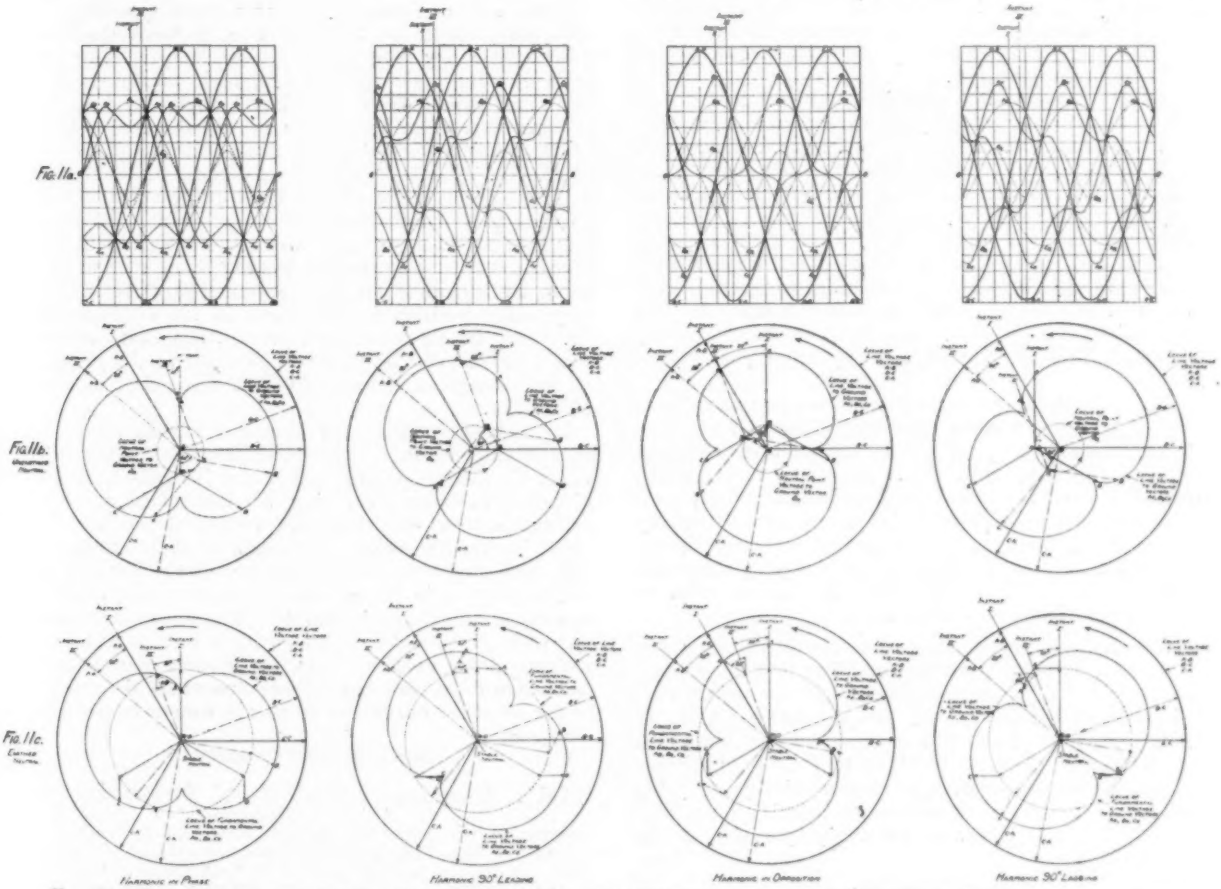

Fig. 11.—Rectangular and Polar Co-ordinate Forms of Fundamental and Third-Harmonic Voltages in a Symmetrical Three-phase, Three-wire, Star-connected System.

(*c*) Possible resonance at third harmonic frequency of transformer windings and line capacity.

These disadvantages may briefly be referred to as follows:—

1*a*. In practice, overheating of the transformer windings and load due to the circulation of third harmonic current very rarely occurs, as care is generally taken to design the transformer so that the flux density in the core is not given too high a value which would increase the third harmonic component of the no-load current. Apart from the question of design, a transformer might, of course, have a higher voltage impressed upon it than that for which it was originally designed, but in this case (which also seldom occurs), the increased heating from the iron loss due to the resulting higher induction would be much more serious than the increased heating in the transformer windings due to larger values of the third harmonic circulating current. These remarks hold good irrespective of whether the transformer windings are delta connected or star connected with a fourth wire.

The only case where the circulation of the third harmonic currents is likely to become really serious in practice is where the transformer primary windings are connected in the interconnected star manner, the generator and transformer neutrals being joined together, as mentioned previously in this article.

1*b*. It is well known that harmonic currents circulating in lines paralleling telephone wires or through the earth where a telephone earth return is adopted, produce disturbances in the telephone circuit. This is only of practical importance in transmission or distribution lines of some length (as distinct from short connections to load), and then as a rule only occurs with the star connection using a fourth wire, which wire may be one of the cable cores or the earth.

Similar interference may take place in the pilot cores of discriminative protective gear systems, and unless special precautions are taken relays may operate when the main power circuit is quite normal.

The remedy is, of course, obvious, and consists either of using a delta connected transformer winding or omitting the fourth wire and earthing at one point of the circuit only.

1*c*. In the case of three-phase core type transformers using a star/star connection, it has been proved experimentally* that a fourth wire connection on the primary

* "Transformer Core Loss as Affected by Triple Harmonics," by H. M. Lacey and C. H. Stubbings. *The Electrician*, September 17th, 1915, p. 874.

side between transformer and generator neutrals (which allows the circulation of third harmonic currents), results in an increase of the iron loss in the transformer of a figure of the order of 20 per cent. higher than that given with the neutrals disconnected. This figure is, of course, variable according to the design of the transformer and the impedance of the primary circuit. The conditions are similar for single-phase transformers.

2*a*. It has been pointed out previously that with the three-wire star connection and isolated neutral a voltage occurs from the neutral point to ground having a frequency of three times the fundamental, so that while measurement between the lines and from lines to neutral indicate no abnormality, a measurement from neutral to ground with a sufficiently low reading voltmeter would indicate the magnitude of the third harmonic. In practice with single-phase transformers the third harmonic voltages may reach a magnitude ot 60 per cent. of the fundamental, and this is a measure of the additional stress on the transformer windings to ground. While due to the larger margin of safety it may not be of great importance in the case of ordinary power distribution transformers, it will have considerable influence on the reliability of transformers as higher voltages are approached.

2*b*. Due also to the conditions outlined in 2*a*, star connected banks of single-phase transformers connected to an overhead line or underground cable, and operated with an earthed or unearthed neutral will result in an electrostatic charging at third harmonic frequency of adjacent power and telephone cables. This produces abnormal induced voltages to ground, if the adjacent circuits are not earthed, the whole of the circuit being raised to an indefinite potential above ground even though the voltages between lines remain normal. The insulation to ground, therefore, becomes unduly strained, and the life of the apparatus probably is reduced.

2*c*. A further danger due to the conditions outlined under 2*b* is the possible resonance which may occur at third harmonic frequency of the transformer windings with the line capacity. This can occur if the transformer neutral is earthed or unearthed, and the phenomenon occurs perhaps more frequently than is usually appreciated, but due to the present-day complicated networks, and the resulting large damping constants, the magnitude of the quantities is such as often to render the disturbances innocuous.

Acknowledgments.—The various curves in the article have been built up from data relating to the hysteresis and permeability of transformer silicon steel which were kindly supplied by Messrs. Joseph Sankey, Ltd., of Bilston, to whom the author expresses his cordial thanks. He is also considerably indebted to Mr. H. M. Lacey, B.Sc., for his co-operation in mathematically analysing the non-sinusoidal wave forms contained in this article, and to Mr. A. C. Turner for the preparation of the illustrations.

APPENDIX.

As, in practice, third harmonic voltages rather than currents are more likely to give trouble, it will be profitable to study the phenomena a little further. Fig. 11 is given, which shows the rectangular co-ordinate method of wave construction translated into the polar co-ordinate form in which the angle represents time, one complete revolution equalling one period or $1 \div f$ seconds. Taken in conjunction, the two forms give a very complete illustration of the progressive variation of the quantities involved while the polar diagram in particular provides a clear insight into the influence of the harmonic.

Fig. 11*a* is in part a reproduction of fig. 8, which shows the resultant voltage waves to ground in a symmetrical three-phase three-wire star-connected system, with different positions of the third harmonic component. In addition, the voltage waves between lines are shown, and these illustrate the well-known fact that no matter what the relative position of harmonic and fundamental may be the third harmonic voltages in the phases cancel out and leave the line voltages free from their influence. In fig. 11*a* the various letters have the following significance:—

An, Bn, Cn = fundamental sine waves of phase voltages.

On = third harmonic sine wave voltage component.

AO, BO, CO = resultant waves of voltages to ground.

A-B, B-C, C-A = sine waves of voltages between lines.

Fig. 11*b* shows the polar diagrams corresponding to the different rectangular co-ordinate diagrams of fig. 11*a* for a system having an unearthed neutral. The diagrams show clearly the locus of the voltage vectors of the neutral point to ground, the lines to ground, and the line to line. The first and third of these, it will be noticed, are true circles having their centres at the point "O," thus indicating that the voltage from the neutral point to ground and also the voltages between lines follow the sine law. The non-sinusoidal characteristic of the voltages from each line to ground is indicated by the expansion and contraction of the curve representing the locus of the line voltage to ground vectors, and the four cases given, corresponding to different positions of the harmonic, indicate that the locus curves are identical in shape, varying only in their relative position. That is, their maximum and minimum values occur at different angles or instants of time, this alone accounting for the different shapes of the resultant waves AO, BO, and CO, in the diagrams of fig. 11*a*. The angular distances between the maximum and minimum values of the locus curves of the line voltages to ground vectors remain constant. To show just how the radial vectors themselves are affected, the conditions at two definite instants are given, the instants being 20 degrees of the fundamental apart; their corresponding position is also shown in the diagrams of fig. 11*a*. In all cases the vertical components of the radial vectors will be found to be equal to the heights of the corresponding waves above or below the zero line of fig. 11*a*.

Fig. 11*c* shows the polar diagrams for the same instances as given in figs. 11*a* and 11*b*, but for the case where the neutral point of the system is earthed. These diagrams show that earthing the neutral in no way affects the locus of the voltage vectors of the lines to ground or the line to line, nor does it affect the minimum and maximum values of the former, or the instants at which they attain these values. As the neutral point is earthed, the third harmonic voltages appear at the line ends of the vectors representing the phase voltages, with the result, as shown, that for the cases of unearthed and earthed neutrals the voltage stresses on the system so far as third harmonics alone are concerned remain the same.

Cable Protection.—The *Technical Review* abstracts an article from the *A.E.G. Mitteilungen* by H. Pfannkuch regarding a cable protection system devised by the author.

With the Merz-Price and other protective systems, defective cable lengths are usually cut out without affecting the rest of the networks, but short circuits between phases or from phases to earth are not avoided. The system devised by Herr Pfannkuch is claimed to remedy this defect. It consists in lightly insulating the wires of the outer layer of each cable core from each other and from the inner portion of the conductor by means of a very light paper lapping. The wires of the outer layer are then divided into two groups, and by means of small series transformers at each end one group is slightly raised in voltage, and the other slightly lowered with relation to the central core. The difference is of the order of 20/50 volts. Electrical stress under fault conditions renders the light insulation conductive, and removes this potential difference, releasing a super-imposed current which operates a switch. There is said to be no appreciable difference in cable diameter or cost over the ordinary type.

The method adopted is reminiscent of the means proposed by Mr. L. R. Lee, in an article contributed to the Electrical Review,* a short time ago, to determine the condition of the lead sheath and insulation of a cable. In this case, however, the outer wires were composed of pairs of dissimilar metals lightly insulated from one another and from the cable. The ingress of water, due to faulty sheathing, caused a small current to be set up by the couples, deflecting the needle of a connected galvanometer.

* "Maintenance Insulation Tests on Electric Cables," Electrical Review, July 30th, 1920, p. 154.

THE APPLICATION OF ELECTRIC LOCOMOTIVES TO MAIN-LINE RAILWAY TRACTION.

By LIEUT.-COL. H. E. O'BRIEN, D.S.O., A.M.I.E.E.

(*Abstract of paper read before the* Institution of Electrical Engineers.)

At the present time there are about 1,200 electric locomotives in service on the railways of the world. Three-phase and single-phase motors did not lend themselves to compact designs, particularly if speed variation was to be obtained economically, and, therefore, improved design of d.c. motors led to a tendency to revert to the use of the geared d.c. motor, which has now become simpler to construct, more efficient, flexible, compact, and cheaper to maintain than the other types; *e.g.*, commutators as now designed give practically no trouble, and brushes and contactors can run for long periods without attention. To illustrate the reliability of motors and equipment designed even so long as 16 years ago, an extension of the figures presented to the Institution of Mechanical Engineers by Sir J. A. F. Aspinall in his presidential address in 1909, and the schedule of overhaul periods adopted on the Manchester and Bury line with the most modern designs are given by the author in appendixes. The commutators of the Manchester and Bury motors give indications of having an indefinite life, while on the Liverpool and Southport line 90 per cent. of the original commutators are still running. Desire for simplicity in the construction of the locomotive, a much extended knowledge of the design and manufacture of gears (the average life of the gears on the Liverpool and Southport line has been 300,000 miles, and of the pinions 200,000 miles), and the necessity for preserving space in the superstructure for control gear, has also inclined designers in this direction. The original commitments have influenced the practice in different countries; generally the a.c. motor driven by a rod linkage is the more favoured on the Continent, while the Anglo-Saxon opinion tends towards the geared d.c. motor.

Design.—Electric locomotives fall into two main divisions: Freight, the maximum speed of which need not exceed 45 m.p.h.; and passenger, which must be capable of a maximum speed of 70 m.p.h. The characteristic torque of an electric, as compared with a steam locomotive, is such as to enable the draw-bar pull of the electric locomotive to be maintained at lower speeds in a way that is not possible with a steam locomotive. This characteristic makes the high acceleration of the suburban electric passenger train practicable. On a heavily graded line an electrically hauled train will maintain higher speeds on the up grade, and will be equally fast, if required, down grade; hence, for fast schedules on lines with gradients, the electric locomotive need not be capable of as high a maximum speed as the steam locomotive, and the electric locomotive on a line containing grades enables a 20 to 30 per cent. faster schedule to be maintained. The increase in schedule is also partly due to the possibility of the regenerative braking, and to a small extent due to the more rapid acceleration of the train from rest. In the Zossen experiments a speed of 120 m.p.h. was obtained with a coach carried on two six-wheel bogies; on the Liverpool and Southport line and the Manchester and Bury line 60 m.p.h. is attained with perfect steadiness, in the former case on a road bed with a sand foundation. When the bogies are placed together and carry a heavy superstructure the natural period of the whole vehicle is increased and oscillation tends to occur at high speeds; it has, therefore, become general practice to provide high-speed electric locomotives, whether the driving wheels are carried in a fixed frame or in bogies, with carrying axles fore and aft, either of the pony, radial, or bogie type, whereas practice again has shown that for goods locomotives no carrying axles are necessary. Excessive wear on curves due to the low centre of gravity of the motor bogies of suburban electric coaches, has led to a desire to raise the centre of gravity of the bogie, and incidentally of the whole locomotive. The height of the centre of gravity of a motor bogie coach is 43 in., whereas that of a steam locomotive of comparable power is 58 in. As long as the geared design of motor is adhered to, the only possible method of increasing the height of the centre of gravity is to rotate the motor into a vertical position. In the case of a 250-h.p. motor on a 42-in. wheel, this involves carrying a dead weight of approximately 4 tons on the axle, instead of 2 tons, as in the case of nose suspension; a compromise is to tilt the motor at 45 deg. By the use of a quill the motor weight can be entirely spring borne, but at the expense of complication of moving and, therefore, depreciating parts.

This design is comparatively untried, and little is known about its maintenance costs. In any case the room required in the superstructure for accessories precludes any greater raising of the centre of gravity than is given by tilting the motors to 45 deg.; a 25 per cent. increase in the height of the centre of gravity of wheel axle and motor resulting in only a 13 per cent. increase in the dead weight on the axle. The motor weight is approximately 25 per cent. of the total locomotive weight. As the electric locomotive will in general be designed with a 58-in. wheel to obtain better adhesion, form of tooth in the gearing, and lower journal speeds, this in itself raises the centre of gravity of the motors by 8 in., as compared with the usual motor bogie design for suburban services in which a 42-in. wheel is the maximum diameter used. If the motors are carried on bogies, the bogie tends to behave as a separate vehicle so far as lateral movements induced by a low centre of gravity are concerned. The raising of the centre of gravity is, therefore, more important in the bogie type of locomotive than where motor axles are carried in frames to which the superstructure is rigidly attached. The use of bogies carrying motors, so far as high-speed electric locomotives are concerned, appears to involve an undesirable complexity for any 4-motor unit, as the rigid wheel base in such a case will not exceed that of a 0—8—0 steam locomotive, while a larger degree of side play in the boxes will be permissible than is the case with the steam locomotive with coupling rods. Where it is desirable to use 6-motor units, an articulated 2—6 + 6—2 design will be cheaper to build and give better results in running than a similar design with a loose superstructure carried on bogies.

The maximum steam locomotive draw-bar pull occurs at starting, and falls off continuously with increase in speed, whereas the maximum draw-bar pull can be maintained in the electric locomotive up to from one-third to a half of its maximum speed. Higher speeds on up grades can, therefore, be maintained without increase in the maximum draw-bar stresses imposed on the train couplings, and as the maximum draw-bar h.p. of typical powerful British steam locomotives does not exceed 900 h.p., it may be assumed that for many years to come no electric locomotive exceeding 1,500 draw-bar continuous h.p. will be required on English railways. No motor exceeding 250 h.p. is likely to be required for British railways, as a combination of six such motors will give 1,200, or two four-motor equipments in multiple unit will give 1,600 draw-bar h.p.

A 4/1 gear ratio is sufficient to give as high a tractive effort as can be utilised with a 58-in. wheel on a locomotive on English railways with a 250-h.p. motor unit. Such a motor with a rated h.p. speed of 600 r.p.m. and a maximum speed of 1,200 r.p.m. would give a maximum speed of 45 m.p.h. with a 4/1 gear, and 90 m.p.h. with a 2/1 gear.

The usual gear construction, with the gear pressed and keyed on to the axle, gives rise to torsional stresses which invariably produce fracture near the wheel seat. The axles of the L. & Y. motor cars equipped with 150-h.p. motors run an average of 170,000 miles before signs of incipient fracture occur. The failures of axles could probably be completely eliminated by keeping the gear wheel clear of the axle and transmitting the drive directly to twin gears bolted and pressed directly on to the wheel centres.

The value of utilising the full number of motor combinations in 4- or 6-motor equipments has not been proved in suburban traction owing to the greater weight and complication involved and the short period of acceleration, but for locomotive work the acceleration periods are bound to be much longer, and much greater speed variations are required; hence for main-line work the full number of combinations will be found essential, and the cost and complexity due to the number of contactors will have to be overcome either by standardisation and quantity manufacture or by reversion to the type of control employed on the Liverpool and Southport line. The direct control system has but two disadvantages, its inadaptability to double heading with a single engine crew, and the rather heavier manual work thrown on the driver. It has been shown that a single electric locomotive within the standard loading gauge can handle heavier and faster trains than any steam locomotive that can be designed for British conditions, and that such a locomotive will not exceed 1,500 rated h.p.

Operation.—The advantages of the electric locomotive from an engineering point of view may be briefly enumerated:—

1. Mechanical efficiency is constant for any given tractive effort throughout the life of the locomotive, while that of the steam locomotive diminishes, particularly as regards the boiler, in progressively increasing ratio to the time it has been out of the shops.

2. No coal and no water has to be carried; as the weight of coal, water, tanks, and tender represents 20 tons per locomotive on the average, the electric locomotive on this score alone has increased hauling power of two loaded 5-ton wagons, or one bogie coach per train.

3. The mechanical efficiency is probably higher than that of the steam locomotive, even at full loads. Hobart shows that the efficiency of collector shoe to draw-bar for medium speeds is in the neighbourhood of 80 per cent. Actual dynamometer car tests show a mechanical efficiency of the steam locomotive of 72 per cent. at 40 m.p.h. for a 2—6—0 type, with a 5 ft. 8 in. wheel, and 82 per cent. for a 2—8—0 type at 20 m.p.h. with a 4 ft. 6 in. wheel. Owing to the efficiency characteristic of the series traction motor, trains can be run more efficiently than with a steam locomotive, for the efficiency remains practically constant from full to half load, which is not the case with a reciprocating engine and boiler;

hence the electric locomotive can, without loss of efficiency, handle a wider range of loads than the steam locomotive.

4. The tractive effort is more even, the gain in adhesion being of the order of 20 per cent. With a steam locomotive the slipping that occurs may often take place for a portion of a revolution only, and slipping that starts with a full regulator opening, results in a momentarily reduced coefficient of friction between rail and wheel and continues until the regulator is closed. With the series motor, on the other hand, the back e.m.f. rises, due to the increased speed, and the current and torque are automatically reduced.

5. The repairs are smaller. An electric locomotive may be expected to run 100,000 miles without failure or renewals of anything except brushes. The average life of the principal parts of the Liverpool and Southport motor cars is given below; the average for locomotives on main-line working, which is much less severe as regards the electrical equipment than a suburban service, might be expected to be double these :—

	Miles.
Armature life between rewinds	131,250
Gear life between renewals	250,000
Armature bearing life	73,000
Average life of a steam locomotive boiler to complete renewal	212,000

It should be borne in mind that the design of standard electric locomotives for main-line work in this country can be commenced on the basis of a wealth of experience gained in the much severer service of high-speed electric traction. It is stated by McHenry that the actual coal economy effected by electrification on the New York, New Haven, and Hartford Railroad was: Passenger services 50, freight services 60, and shunting services 66 per cent., while the cost of repairs per engine-mile was expected to be less than half. The substitution of the electric for the steam locomotive would effect an economy of not less than 33 per cent. in repairs, and 50 per cent. in coal consumption. It should be further taken into account that the repairs to electric locomotives do not in general demand any complete dismantling of the locomotive; the repairs are confined to the periodic removal of the wheels for turning, and the motor armatures for rewinding at much longer intervals.

(6) No washing out of boiler or removal of ashes, (7) less cleaning, and (8) less lubricant required, 0.01975 pint per mile, Liverpool and Southport and Manchester and Bury cars approximately 800 h.p. rated motor capacity; 0.0726 pint per mile, average of Lancashire and Yorkshire locomotives, (9) no detentions due to lack of steam, (10) less failures, causing interruption of traffic, (11) more rapid shunting, (12) regenerative braking possible, (13) no turn-tables required, (14) cheap and efficient supply of electricity for lighting, cranes, &c., (15) roads now used by engines going to and from shed to turn, for water or for coal, would be available for traffic purposes, (16) more than half the wagons now used for locomotive coal would be freed for other traffic, equal to 2.4 per cent. of the whole wagon stock, (17) owing to the more continuous use made of the locomotives, and the consequent smaller number, at least 33 per cent. of the locomotive sheds and shed yards could be devoted to other purposes, (18) the electric locomotive within the standard minimum load gauge of the British Isles can be made 50 per cent. more powerful than any existing steam locomotive. Any necessity for strengthening bridges to meet the needs of more powerful locomotives could be obviated by a general electrification. One of the serious problems in connection with increasing the load gauge in the British Isles to the Continental load gauge would be the consequent necessity for strengthening the bridges and viaducts to meet the more powerful steam locomotives which would have to be used, (19) double heading with a single train crew is possible, (20) automatic increase of torque with reduction in speed enables tonnage loading to be maintained over variable grades without reduction in schedule.

The disadvantages are: (1) Liability of hold-up of all trains due to failure of power supply, (2) difficulty in heating existing carriage stock, (3) in controlling acceleration in shunting operations, (4) arising from presence of a trolley wire or third rail and the collection therefrom, (5) in arranging locomotive and stock workings to give the locomotives the continuous use of which they are capable, (6) assumed higher cost per ton of electric locomotive as compared with a steam locomotive of same maximum horse-power.

Difficulty (3) can be overcome by the use of all four or all six motors in series and the use of liberally proportioned resistances and by field control; the a.c. motor has an advantage in this respect in a greater number of running speeds being available. Regarding (4), the trolley is inflexible with regard to extensions, and difficult to install or repair without interruption to traffic, and is a serious obstruction to the breakdown crane. The third rail is an obstruction on the track and, therefore, objectionable inherently; it is rather a serious obstruction to the ordinary maintenance of the track and intolerable in sidings where much shunting is done. The probability is that in main-line electrification the third rail will be used where track complications are not great and where little shunting is done; the trolley elsewhere. In Great Britain there exist two types and three positions of the third rail, three d.c. and one alternating voltage, but the most suitable voltage of supply remains undecided. The author does not consider that the existence of the comparatively few suburban electrifications at 600 or 1,200 volts should militate against the adoption of a standard of 1,500 volts. The use of 1,500 volts is desirable solely for the sake of future main-line electrification work for the economy arising from concentrating the sub-station machinery in fewer sub-stations. It is practicable to operate locomotives at two voltages, but the facility is dearly bought as regards first cost and maintenance. The suburban electrifications that exist at 600 volts are almost self-contained, and on the short mileages where main-line stock utilises suburban tracks, duplication of the collecting system by putting the higher voltage overhead is preferable to saddling the main-line system with other motors permanently in series and additional contactors. In some few cases half-speed operation of the main-line locomotives would meet all requirements.

The cost of electric locomotives is high, but this is due more to the experimental nature of the designs and the small number built to any particular design rather than to any inherent feature of the electric locomotive. The frames, wheels, brake rigging, draw gear, and superstructure of an electric locomotive should cost no more than in the case of a steam locomotive. These items represent approximately 60 per cent. of the total weight. The cost of an electric locomotive built in large quantities and to standardised designs should not exceed that of a steam locomotive capable of doing the same work.

Financial Aspect.—Deductions favourable to electrification have been drawn from general figures applying to the whole of the railways of Great Britain or the United Kingdom, but even as indicating tendencies only, such figures must be taken with caution. There is a certain density of traffic below which an economy will not be obtained sufficient to pay an adequate rate of interest on the capital expenditure in electrifying, or to provide a sinking and renewal fund. Even on the L. & Y. Railway there are many route miles on which the traffic would not warrant electrification. A rough estimate of the cost of electrifying the whole of this railway on which traffic is so dense indicates that probably the return would be less than 3 per cent. The salient points are the very large proportions of the total capital expenditure debited to the transmission (11.2 per cent.), track (40 per cent.), and locomotives (25 per cent.), and the very clear indication given of the substantially greater return on capital expenditure which would be obtained by retaining steam operation for those services on which the expenditure per mile for fuel and repairs was low.

It is evident that if electrification is to be regarded from the point of view of economy in operation denser traffic areas must be sought than are offered by the whole Lancashire and Yorkshire system, dense as is its traffic compared with the average for England and Wales. On the other side of the scale are the improved facilities offered for the movement of traffic and the possibilities of increased revenue. Given sound engineering design the ratio: Cost of power-producing plant/cost of track equipment and locomotives will give a general indication of the probable commercial success of an electrification scheme. For a typical suburban electrification this ratio is approximately 1; in the case under consideration it is approximately 0.25.

It is evident that, in the case under consideration, if the track to be electrified could be reduced by one-half, while the number of locomotives required is only reduced by one-third, then the total capital expenditure would be reduced to one-half, while the economies effected might only be reduced by one-fifth. Immediate electrifications will be limited to densely trafficked sections of the main line when a maximum continuous use can be obtained from both locomotives and track equipment, and where the expenditure on these items is such that the expenditure ratio is 0.5 or more.

Conclusion.—The continuous use of both the locomotives and track is the key to the whole problem of main-line electrification in its financial aspect, and this is rather a railway than an electrical or mechanical engineering problem. It is for the engineer to design an electric locomotive sufficiently flexible to work efficiently either goods or passenger trains; those responsible for traffic operation have the equally difficult task of arranging the workings for the train services, which must suit the public convenience, in such a way as to secure the continuous use of the tractors, which is made practicable by electric traction; not the least difficult point to be dealt with in investigating this is the arrangement of the change-over from electric to steam haulage at the terminals of the electrification. It is also for the traffic department to determine whether greater loads hauled and the higher average speeds and more rapid clearing of the block sections will enable their work to be done so much more efficiently and economically as to compensate for the increased costs of locomotive operation consequent on such increased loading and acceleration.

The author has endeavoured in a broad way to draw the conclusion, confirmed by what has been done on the Chicago, Milwaukee and St. Paul and on the Italian and Swiss railways, that sufficient data and experience exist to enable the engineer to design electric locomotives of the type required, and to predetermine with accuracy the capital expenditure and operating costs, but that the determination of the most suitable sections to electrify is essentially a traffic problem. He ventures to join in the plea for the immediate appointment of committees to deal with the standardisation of third-rail position and voltage, motors, gearing, contactors, and locomotives.

Discussion at Bristol.

The paper was discussed at a meeting of the Western Centre of the Institution of Electrical Engineers at Bristol on February 7th.

The Chairman (Mr. A. J. Newman), speaking with regard to the financial aspect, thought it would be a very long time before they would see main line electrification if 3 per cent. only were offered on the capital invested.

Prof. F. Bacon inquired why a low centre of gravity led to severe wear on curves. Was there not a possibility of substantial saving in rail wear on straight portions of the track, due to the reduced slip and improved adhesion resulting from the uniform character of the driving torque and the absence of only partially balanced reciprocating masses?

Mr. W. Nairn said the author, when dealing with regenerative braking, mentioned the special case of the Chicago, Milwaukee & St. Paul Railway. That line, however, was a very special case, as on one of the electrified portions the train started on the top of the Rocky Mountains and ran downhill for over 200 miles towards the Pacific. One could understand regenerative braking being a success in such a case, but he did not think the extra expense and complication would be justified in this country. The extra equipment on the St. Paul locomotives was a serious item; when regenerating, the motor fields were excited from separate d.c. generators driven from the locomotive axle, two of which generators of 50 kW capacity each were installed on each locomotive. The fields of those exciters were further separately excited from either a battery or a motor generator and were controlled by a motor-driven rheostat. He felt that such complications would not be justified in this country. With regard to axle failures, he agreed that the proper fixing of the gear wheel would appear to be to bolt it direct to the road wheel, and he would further suggest the fixing of gears to both road wheels and the replacement of the 250-h.p. motor with two 125-h.p. motors connected permanently in series, one armature being geared to each road wheel. That arrangement would only give 750 volts across each armature instead of 1,500 volts, and he understood the 750-volt motor was not so liable to flash over as the 1,500-volt one.

Mr. I. A. D. Pedler asked the author how he accounted for the 70 per cent. load factor.

Mr. A. Willis thought it might be of interest to say that last year he attended a demonstration of "Shunting" by the somewhat unsatisfactory and perhaps inefficient battery locomotive. He was assured by the engineer that the saving was more than 50 per cent., as it was possible to arrange the trains and place them on a special piece of track set out for the purpose, so that the main-line engine did not enter the actual goods siding, and he suggested that that might be a solution to the difficulty in connection with the third rail, or overhead network, on sidings. It was difficult to see why breakdowns should be expected more in sidings than on the main line, but where overhead wires were being used there was an unfortunate tendency to replace the soft aluminium collecting strip by materials of a much harder nature, such as copper or even steel. That must lead to excessive wear on the trolley wire and eventual breakages of the overhead line. With reference to the author's comments in connection with pantograph current collectors, in most systems pantographs were controlled by compressed air; the pantograph was normally down, and was raised by the driver letting the air flow from the air chamber to the pantograph cylinder. Surely it would not be difficult for him to carry out that operation when he saw a tunnel or obstruction ahead? As regarded the third rail, what was the possibility of trouble occurring in connection with the motors due to the constant making and breaking of the current as it would appear in such a country as this, where large towns were very close together, and the mass of crossings, points, junctions, &c., would necessitate the constant breaking up of the third rail into sections?

Mr. T. Hood said the advantages of a.c. for long-distance transmission had been on the Continent the factor which determined its use for railway electrification, and motors of the single-phase type, designed by Winter and Eichberg, appeared to have been satisfactory. It was true that when the electrification of the underground railways was projected the controversial advantages of a.c. and d.c. formed the subject of an inquiry, and finally the d.c. system advocated by the Americans was adopted.

Mr. H. I. Rogers, as a manufacturer of trolley standards, more particularly for tramways, was naturally in favour of overhead transmission rather than the third rail, but there were, probably, advantages in both. The automatic raising and lowering of the pantograph bow at certain points might be got over. In tramway work various devices had been manufactured for raising and lowering the arm in the case of de-wiring, but the speed and weight of trains made the problem more difficult on railways. As regarded shunting, the author thought there would be no reduction in the number of electric locomotives as compared with the number of steam locomotives. The speaker had always thought it was one of the great advantages of electric over steam traction that shunting would be very much simplified, and the much greater mileage of the electric locomotive before it was necessary to overhaul it must surely in itself mean a saving in the number of locomotives involved in shunting.

Mr. C. F. Waddington explained that one reason why d.c. had been adopted was that batteries could be used for levelling up the loads on the peaks.

Mr. W. A. Chamen considered geared motors hopeless for heavy continuous loads. The financial aspect of the whole thing came as a bit of a shock to him.

Mr. A. C. Macwhirter pointed out that the author advocated 1,500 volts, but in America 3,000 volts was adopted. He considered standardisation was the one thing which ought to be forced right home in railway equipment.

Mr. S. P. Haslam congratulated the author on the very fair manner in which he summed up the disadvantages and advantages of main-line electrification. Some of the disadvantages appeared almost insuperable. He thought the author had underestimated the mileage run by steam locomotives between repairs, and he considered 100,000 miles a fair figure.

Discussion at Liverpool.

The paper was first read and discussed at the Preston Sub-Centre on January 5th, 1920, and at the Liverpool Sub-Centre of the North-Western Centre on March 15th, 1920, but was not then available for publication.

Prof. E. W. Marchant, chairman of the Sub-Centre, presided, and said Col. O'Brien had referred to the fact that, with electric trains, it would be possible to carry heavier loads than with steam traction, because of the more even distribution of the weight of the locomotive, but the speaker had understood from Mr. Roger T. Smith's presidential address that the largest expenditure in connection with electrification was involved in the alteration of the "structure gauge." Mr. Roger Smith made out a strong case, on commercial grounds, for the electrification of railways for goods traffic, and the speaker thought that electrification for passenger traffic was likely to come about through the greater comfort of the passengers travelling in electrically-driven trains.

Mr. J. Shaw quoted a number of figures from his own experience on the Mersey Railway of an average of three years' working under steam and three under electricity on the same line of railway. The consumption per ton-mile during steam working was 0.453 lb. of coal costing 16s. per ton, and during electrical working 0.436 lb. of slack at 8s. 9d. per ton, which showed a saving of practically the 50 per cent. quoted in the paper. The position of the motors and the horse-power to be adopted were closely allied to the problem of design and strength of the axles. Col. O'Brien stated that on the Southport line the motor cars equipped with 150-h.p. motors ran an average mileage of 170,000 miles before incipient signs of fracture occurred. On the Mersey Railway they had recently had the first broken axle since electrical working commenced 17 years ago. The majority of their axles were of American manufacture, and the one which broke was one of the few English axles which they had in service; it was a motor-car axle, and had run 650,000 miles, and the fracture occurred between the running and the gear wheel. The suggestion of making the gear wheel part of the running wheel would appear to be worthy of serious consideration when dealing with motors of large power, but it would probably resolve itself into a question of whether it was cheaper to spend money on running wheel replacements or axle replacements. In the paper a comparison was made of the costs of steam and electric locomotives, the figures being respectively £900 and £1,500, but the speaker did not agree that that was a fair comparison. A steam locomotive when put into service had all the power to drive it, whereas an electric locomotive required a power house and a proportion of the cost of the power house plant and distributing system must be added to get a fair comparison of the relative values. The figures given with regard to the life of the parts showed that under electric traction the parts as they were designed 16 to 20 years ago had stood remarkably well considering there was very little experience at that time. On the Southport line they had 90 per cent. of their commutators in use, and on the Mersey line there had only been one replacement in 19 years. Their armatures were running about 131,000 miles between rewinds and those on the Mersey line about 380,000 miles.

Mr. F. J. Teago explained that Col. O'Brien's statement about the maximum locomotive draw-bar pull was as it stood questionable, because the maximum steam locomotive draw-bar pull depended upon the throttle opening and the point of cut-off, both of which were controlled by the driver. To avoid skidding it was unlikely that the driver would start "all-out" and, therefore, it would be possible for him to increase his draw-bar pull for some time after starting. Col. O'Brien's curves showed that the steam locomotive sustained its draw-bar pull at high speeds better than the electric locomotive did. That was probably due to the low centre of gravity of electric locomotives in general, which tended to make the vibration high, and caused a loss of adhesion; that, however, was a point of mechanical design which was being remedied. Undoubtedly electric traction would, even in this country, supersede steam traction, and Col. O'Brien had stated the reason clearly.

Mr. S. E. Povey was of the opinion that the electrification of main-line railways required early investigation. It would undoubtedly come from the necessity for the conservation of coal, and because electrification was cheaper than the present railway working; the elimination of smoke in the vicinity of locomotive sheds and large sorting sidings was a feature. The

spring-quill drive would be necessary for motors of over 250 or 300 h.p., but the use of the quill drive should be avoided if possible, hence he was in agreement with the author that the use of a number of 200 or 250-h.p. motors was preferable to the use of a few large motors. The author had used the one hour rating in giving the h.p. of the locomotive, but on continuous goods and express-passenger services the continuous rating of the motors would have to be taken into account. The conditions when working express-passenger or goods trains was much less severe than a suburban high-speed passenger train service. The experience already obtained of the maintenance of suburban electric railways showed that an electric locomotive could be designed to run continuously in traffic for a week without any maintenance being required or the necessity for it being taken into the shed. He agreed with the author that the problem was now one for the traffic departments to arrange passenger and goods services to provide for continuous working of electric locomotives.

Mr. J. Hamilton thought that the paper pointed to the need for further progress both in generation and application before they could claim that electricity should be the sole motive power for railways. Taking the author's figures, nine electric locomotives would do the work of twelve steam ones, and assuming 15 units at the power station per engine mile, had the railways of England and Wales been run electrically in 1913 it would have meant an annual output of approximately 6,000,000,000 units, with an average haul load on the power station supplying them of the order of 750,000 kW.

Mr. Lang hoped that before very long they would have electric traction all over the country. It was perfectly obvious that in spite of the difficulties of being able to show the prospect of a financial success, the result always had been a financial success. In putting forward a scheme of that kind, electrical engineers were much too diffident in making claims for success.

Mr. L. C. F. Bellamy pointed out that they had heard a lot about geared motors, and he regretted that time had not permitted the author going more deeply into the merits of the gearless motor, on the same principle as some locomotives that had been operated with remarkably good results for the past ten years on the New York terminal of the New York Central Railroad. If, by the adoption of the gearless motor they could eliminate gears, pinions, jack-shafts, and side-rods, together with both armature and suspension bearings, they ought to be prepared to make some sacrifice in the direction of extra weight of motor which would be necessary by reason of the comparatively low speed of the armature. The speaker also compared some of the author's conclusions with those of Messrs. Merz and McLellan, given in their report on the electrification of the South African railways. The author recommended (1) the third rail (with certain exceptions) as a conductor, whilst Merz and McLellan preferred overhead equipment; (2) a line voltage of 1,500, whilst Merz and McLellan regarded 3,000 as the ideal; (3) raising the centre of gravity of the locomotive, whilst Merz and McLellan emphasised the fact that it should be kept low.

Mr. J. W. Astley said that it was highly probable that the electrification of main lines would be on the third rail system with d.c. at 1,500 volts, whilst sidings, junctions, and probably large stations on main lines, would be equipped on the overhead system. That would necessitate electric locomotives, &c., carrying both third-rail contact shoes and pantographs, but the change over from shoe to pantograph current collection, to maintain continuity of current, presented no practical difficulties. With regard to double gears on the main axles which were now being tried to prolong the life of the axle, the speaker failed to see that very much benefit could be derived from that arrangement. Presuming that axle fractures were due mainly to crystallisation consequent upon vibration being superimposed upon the torsional stresses, then the clearance and ultimate "backlash" in the gears was sufficient to allow the torsional stresses to be effective, and as the vibrations were always there, the life of the axle must approximately remain the same.

Major C. I. Morris said that the problem of gears and broken shafts appeared to occupy a large place in the discussion, but no speaker mentioned the possible use of paper pinions, or Citroen gears. Had they been tried? Those types of pinions had been used with some success on rolling mill induction motor drives, and the speaker imagined that the case in point was somewhat analogous.

Mr. Rettie discussed electrification in general, more especially from the local point of view, and also gave some interesting facts relating to general features in the mechanical and electrical equipment of main and suburban lines. The following gentlemen also took part in the discussion: Major Carr, and Messrs. Holltum and Bolton.

Lieut.-Col. H. E. O'Brien, in replying, explained that experience on the Lancashire and Yorkshire Railway ranged from 600 to 1,500 volts; the principal advantage in operating at the higher voltage was due to the reduced arcing, both in the contactors and the commutators, owing to the smaller currents dealt with. There was a slightly greater tendency to flash over; generally it was improbable that the higher voltages would involve either higher or lower maintenance costs. Dealing with the oscillation of the locomotive, a long vehicle with a bogey at each end ran, he said, quite steadily, but if the bogies were put close together and the weight of the superstructure increased, a tendency to oscillate occurred, and the bogie wheel base must be increased. As regarded twin gears, the North-Eastern Co. used them, and after running 100,000 miles they were in excellent condition. How they would affect the life of the axle would not be determinable till the mileage approached 300,000. They did not use any special steel for the axles on the Lancashire and Yorkshire system. Many of those axles had run a much longer mileage than that given as the average, but no doubt the axles were somewhat on the small side. The conditions of the South African railways were different from those in this country; in that case the length to be electrified would be several hundred miles, with traffic of comparatively small density. The less the density of the traffic and the longer the distance, the higher would be the most economical voltage, but there was no advantage in a high voltage with the density of traffic existing round London or Liverpool; higher voltages for suburban services were only required with a view to ultimate main-line electrification. Mr. Povey had been serving on a committee investigating the rating of motors; the one-hour rating was an unsatisfactory basis in many ways, but at the moment it was their only standard of comparison. The electric locomotive maintained its draw-bar pull constant up to a predetermined point, dependent on the gear ratio and the train resistance, in a way a steam locomotive could not. However, the actual horse-power of the electric locomotive fell continuously after a certain point, whereas the horse-power of the steam locomotive first increased and then decreased again. High acceleration did not produce much effect upon runs that exceeded 4 miles in length, but on a line with dense goods traffic very often the runs between stops were less than 4 miles long. With a modern power station in which superheated steam was supplied to high-speed turbines, the coal consumption with electric traction would be probably 0.25 lb. per ton-mile, whereas even if superheaters were fitted to steam locomotives it would not be less than 0.4 lb. per ton-mile, which confirmed the author's figures showing that the substitution of electric traction for steam locomotives would cut the coal bill approximately in half. The author's point was that so far as the steam locomotive was concerned, no advance was possible without increasing the structure gauge and if the Channel Tunnel was built it would be necessary to enlarge the structure gauge to the Continental gauge. The Channel Tunnel was, however, not built yet and, so far as electric locomotives were concerned, the present structure gauges and bridges would accommodate electric locomotives of the maximum power it was practicable to use in this country.

REVIEWS.

A Handbook of Physics Measurements. By E. S. Ferry. Pp. 484; 273 figs. New York: John Wiley, 1918. London: Chapman & Hall. 2 volumes; price 9s. 6d. net each volume.

What Kohlrausch's Handbuch did for German physics students in the latter years of the nineteenth century, and what Watson's text book of practical physics did in 1908 for the English student, this handbook purports to do for the present-day physics students in the American colleges. In the words of the preface to volume one, "the aim of the present work is to furnish the student of pure or applied science with a self-contained manual of the theory and manipulation of those measurements in physics which bear most directly upon his subsequent work in other departments of study and upon his future professional career." The book, therefore, covers fundamental physical measurements, properties of matter, and optics, in Volume I, and vibratory motion, sound, heat, electricity and magnetism, in Volume II. Each of these sections consists of two parts. The first includes definitions, a description of the apparatus and the general theory of the methods employed; in the second part of the chapter each determination is described with special reference to manipulation of the experiment and computation of the results.

An introductory chapter deals with general notions concerning errors, degree of accuracy, methods of recording results, and the use of graphs. Chapter 2, which occupies nearly 100 pages, treats of the principles of measurement and the properties of matter. The whole range of measuring instruments from the metre-stick to the planimeter are first described, followed by the balance and some notes on density, specific gravity, friction, moment of inertia, elasticity, and viscosity. Then follows a series of 25 experiments designed to illustrate these properties.

The second part of Volume I is devoted to optics, and here the same method of procedure has been adopted. Commencing with light-units, the various methods and standards of photometry are discussed, followed by a brief treatment of lens systems. Considerable space is given to the subject of refractivity and refractometers, all the chief modern forms being described and illustrated. While this full treatment is amply justified by the growing industrial importance of such methods of testing, the absence of specific reference to such industrial uses except in rare cases is somewhat regrettable. Diffraction gratings, spectrometers and spectrophotometers are then dealt with, followed by a very sound treatment of polarisation and saccharimetry. The subject of sugar scales is given

a due share of attention, and particular stress is laid upon the effects of fermentation and temperature in relation to the determination of solutions containing more than one form of sugar.

The 25 experiments in optics include practical determinations of illuminating power, candle power, constants of lenses and lens systems, refractivities, wave lengths, colorimetry, and sugar strengths. There are also 16 tables of physical constants appended to Volume I.

Vibratory motion, sound, heat, electricity, and magnetism are treated in Volume II along lines exactly similar to those adopted in Volume I. The author rightly justifies the important place given to acoustical experiments by reference to the utility of such work in the war, and claims that the selection of the experiments in the heat and electrical sections has been made with due regard to the determinations now demanded by science and industry. In heat, the inclusion of flash, fire, and cold tests of an oil, of fuel values by the bomb and gas calorimeters, and determinations of the economy effected by lagging steam pipes is all to the good from the industrial standpoint, while the Barnes constant flow method of determining "J" indicates the author's appreciation of modern methods of performing time-honoured experiments. Quite a feature of the section on heat is the clear treatment of the application of the radiation correction to calorimetric experiments.

Barely half of the second volume is left for the subjects of magnetism and electricity, but there is little to be criticised in the method of treatment. A few of the illustrations—such, for example, as that of the outside of a standard cell—could have been well spared to make room for more useful sectional line diagrams, but this is a minor criticism. The experiments appear to have been well chosen to illustrate the principles of the subject and to provide practice in using the chief electrical instruments. A serious weakness, however, is the meagre treatment of magnetic measurements; there is nothing to justify the limitation of this important subject to two experiments covering only ten pages in a course which includes no less than 10 experiments in sound and 25 in optics.

While, apart from the above, there is little that is open to criticism in the electrical part of the book, yet the impression left upon the reviewer is that the author is certainly less happy in this subject than in the preceding sections, and that he even bears some grudge against it appears to be shown by the entire absence of electrical or magnetic tables at the end of Volume II. While very satisfactory tables of general physical, optical, and heat constants are given, one looks in vain for any tables of magnetic or electric constants.

This failure of the course to hold a true balance among the subjects is the only serious criticism we have to offer. In all other respects these volumes are exceptionally sound, and should form desirable laboratory reference books. Any student who conscientiously works through the course of experiments will have performed a considerable number of tests and determinations having a definite industrial value. Perhaps in a future edition the author may find it worth while to extend the electrical and magnetic side of his course, thus adding to its usefulness.

P. H. S. K.

The Mathematical Theory of Electricity and Magnetism. By J. H. Jeans. Pp. vi+627; 178 figs. London: Cambridge University Press. Price 24s. net.

This work, which first appeared in 1908, is too well known to our readers to require any special description at this date. A second edition appeared in 1911 in which was embodied a great deal of the research work which had been made known in the interval, and this is the edition with which most persons are now familiar. The third edition, which was issued shortly after the war broke out, contained the same matter with a few additions, and now, after a somewhat longer interval, the fourth edition has appeared. Our readers, many of whom will be in possession of the work in its earlier form, will be chiefly interested to know what fresh matter is to be found in the book as it is now published, and will, perhaps, not be surprised to learn that what mainly distinguishes this edition from its predecessors is a final chapter on the Theory of Relativity. Indeed, this new theory has made such a profound impression on all branches of science to which it has been applied, that no book dealing with the mathematical aspects of any of them would be complete without an account of the modifications imported, when considerations of relativity are introduced.

We are not here dealing with the general theory of relativity according to Einstein, which explains gravitation as a property of space, but with the special theory of relativity, in Einstein nomenclature, which embraces only co-ordinates moving with uniform velocity. Prior to Einstein's discovery the latter theory was the theory of relativity and the word general prefixed would only have implied that the theory was considered apart from any special application of it. Thus Einstein was taking the validity of the development he contributed rather too much for granted when he appropriated the word general to designate it. In the book under review Einstein's designations are ignored, and his special contribution is referred to as the relativity-theory of gravitation.

Those who have not yet acquainted themselves with the considerations which have to be taken into account when electric phenomena are examined from the point of view relative to the beholder, cannot do better than apply themselves to the last chapter of Prof. Jeans's book. The matter is not simple, and is here treated as briefly as is consistent with lucidity. It is interesting to watch the phases through which faith in an æther goes in the minds of our leading writers on such subjects. As is well known, the theory of relativity requires that if there is an æther there must be as many æthers as there are observers, and each observer must carry his own æther about with him. Now, since each æther is co-extensive with the universe, this is rather a hard doctrine. Mr. Jeans, nevertheless, finds a way of thinking which makes such a state of things less incredible. A number of persons might all see what each one would take to be the same rainbow. In point of fact each one would see a different rainbow—a bow differently placed according to his situation. By careful observation and comparison they might discover that each saw his own rainbow, but this would not show the rainbow to be an illusion, because if the rain stopped there would be no rainbow. And what all see to be, or see not to be, simultaneously, cannot be an illusion. Our author also appears to think that if the theory of relativity is true, and its application to gravitation is not true, the geoid, or surface of mean sea-level on the earth, might be a gravitational equipotential for some one velocity through the æther, but could not remain an equipotential, as the earth's velocity through the æther changed, owing to description of its orbit about the sun. So he deduces that daily and seasonal tidal surges, which are not observed, would occur if the force of gravitation also were not subject to the modifications which considerations of relativity impose. "There seems no longer to be any room for reasonable doubt that gravitational phenomena conform to the relativity condition."

Finally, he places the hypothesis of relativity on the same footing as the two other great dominating principles of physics, namely, the conservation of energy and the second law of thermodynamics. We are inclined to think that the hypothesis of relativity is even more firmly based than that of the conservation of energy, since it reposes on the fact that velocity is relative, and we cannot think otherwise, while conservation of energy has been the slow harvest of experiment. The second law of thermodynamics, on the other hand, is of limited application so far, because it is thought not to apply to living tissue.

We may commend to our readers the fine style with which the whole book down to its smallest detail is wrought.

Electrical Practice in Collieries. By Daniel Burns, M.Inst.M.E., Professor of Mining, the Royal Technical College, Glasgow. Fifth edition. Pp. x+407; figs. 241. London: Charles Griffin & Co., Ltd. Price 10s. 6d. net.

This book, which was first published in 1903, was intended as a text-book for the use of students preparing for certificates of competency as colliery managers, and the fact that it is now in the fifth edition, shows how usefully it has fulfilled its original purpose. It does not, of course, pretend to deal with the latest developments in electrical engineering, or in the details of mechanical construction of electrical plant; but to the mining student who desires a knowledge of electricity and electrical plant as applied to the various purposes of mining work, including winding, haulage, pumping, and coal-cutting, &c., we cannot recommend a better book. Among the features of the book are the fully worked out numerical examples of the various problems and a set of questions and answers at the end of each chapter. Some of these will be found useful not only to the mining student, but to the electrical engineer who may have mining problems connected with haulage, winding and pumping operations to deal with.

The present edition, however, does not differ greatly from previous editions, the illustrations mainly showing old or even now obsolete machines, but, as the author points out in his preface, these are mainly retained to show the development in electrical plant that has taken place in recent years. We question, however, whether this is of benefit to the student, and we think it would be much more to his advantage if the book were brought more up to date. We doubt, for instance, whether any engineer to-day would secure a motor or dynamo with Lewis bolts run in with "sulpher" or even lead, or whether it would be possible to find any incandescent lamps fitted with "loops" in preference to the ordinary bayonet joint holder, and we question whether any motors are to-day in mining work driving machines with either ropes or belts and least of all with "raw hide" belts. Otherwise the book is excellent for its purpose, and we have no hesitation in recommending it to students seeking general information on mining electrical practice, as it deals with every application of electricity from winding machinery to shot-firing.

T. C. F.

An Argentine Wheel Contract.—The Argentine State Railway has awarded a contract to Krupps, of Germany, for 10,000 laminated steel car wheels. The price is 40 Argentine gold pesos for each wheel, delivered. The German corporation agreed to deliver 200 wheels per week, beginning in August. Seventeen companies competed for the contract, bids being received from the United States, the United Kingdom, and other countries.—*Reuter's Trade Service* (Buenos Aires).

NEW PATENTS APPLIED FOR, 1921.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by Messrs. Sefton-Jones, O'Dell and Stephens, Chartered Patent Agents, 285, High Holborn, London, W.C. 1.

6,770. "Direct-current electric motors." Metropolitan-Vickers Electrical Co., Ltd., and R. J. Butler. March 1st.
6,807. "Apparatus for remote control of electric motor lamps, &c." L. Kaudorff. March 1st.
6,815. "Electric transformer voltage-regulators." B. Thomas and E. Thomas. March 2nd.
6,850. "Electric starters and cut-outs for electric lighting plant employing combustion engines." C. C. Garrard, A. H. Railing and W. Wilson. March 2nd.
6,867. "Overhead aerial control." G. Bennie. March 2nd.
6,868. "Electrical apparatus for distant indication of movements of rotatable shafting, &c." H. Meehan and Mechans, Ltd. March 2nd.
6,876. "Telephone transmitters, microphones, &c." S. Hockly. March 2nd.
6,891. "Lanterns, &c., for electric lamps." D. J. Duncan. March 2nd.
6,896. "Electric device for heating liquids, &c." H. J. Preston. March 2nd.
6,942. "Electrically-heated melting, &c., furnaces." Morgan Crucible Co., Ltd., and C. W. Speirs. March 2nd.
6,947. "Electric switches." W. A. Coates (Westinghouse Electric and Manufacturing Co.) and Metropolitan-Vickers Electrical Co., Ltd. (Westinghouse Electric and Manufacturing Co.). March 2nd.
6,928. "Means for electrically controlling ignition of internal-combustion engines." J. R. Charnock. March 3rd.
6,940. "Combined electric fan and radiator." J. George and W. G. H. Morley. March 3rd.
6,942. "Electric lamps for road vehicles." J. Roberts. March 3rd.
6,976. "Electric lamp locking-ring." A. Everett and W. Goodwin. March 3rd.
6,996. "Electrical transmission systems." A. M. Taylor. March 3rd.
6,998. "Using energy given off from the magnetic poles to supply power for machinery, &c." H. Parkes. March 3rd.
7,006. "Shade for semi-indirect electric-light fittings." S. D. White and F. Winstanley. March 3rd.
7,013. "Cooling dynamo-electric machines." H. A. Carney and H. M. Lacey. March 3rd.
7,019. "Electrically propelled vehicles." J. P. Kemp. March 3rd.
7,021. "Electric lamp holders." Compression Starter and Switchgear Co., Ltd., and R. Lomax. March 3rd.
7,029. "Wireless telegraphy." G. M. Wright. March 3rd.
7,032. "Electric motors." A. Rava. March 3rd.
7,033. "Electrophonic signalling and advertising apparatus." A. Rava. March 3rd.
7,035. "Manufacture of electric cables for conveying energy." L. N. Reddie (Soc. Pirelli & Co.) and Soc. Pirelli & Co. March 3rd.
7,036. "Electric cables for conveying energy." L. N. Reddie (Soc. Pirelli & Co.) and Soc. Firelli & Co. March 3rd.
7,037. "Electric cables for conveying energy." L. N. Reddie (Soc. Pirelli & Co.) and Soc. Pirelli & Co. March 3rd.
7,052. "Electric fuses." H. J. Fuller. March 4th.
7,072. "Adjustable electrical temperature alarm." H. Demaine. March 4th.
7,109. "High resistance conductors." British Thomson-Houston Co., Ltd., and H. W. Taylor. March 4th.
7,110. "Electric motor control systems." British Thomson-Houston Co., Ltd., and H. C. Hastings. March 4th.
7,119. "Aerial cable conveyors." W. J. Adan and G. Craddock & Co., Ltd. March 4th.
7,124. "Sparking plugs." B. Scherer. March 4th.
7,134. "Device for recording number of telephone calls." H. A. Levens. March 4th.
7,143. "Electrixators." I. Szarvasy. March 4th. (Hungary, February 15th, 1918.)
7,174. "Railway signalling apparatus." Automatic Telegraph Manufacturing Co., Ltd. March 5th.
7,200. "Electrolysis of brine." J. J. Collins. March 5th.
7,201. "Protective arrangement for high-voltage insulators for electric precipitating installations." Siemens-Schuckertwerke. March 5th. (Germany, March 9th, 1920.)
7,205. "Distributing brush holder for magnetos." Soc. des Moteurs Salmson (Systeme Canton-Unne). March 5th. (France, March 27th, 1920.)
7,216. "Telephone systems." Automatic Telephone Manufacturing Co., Ltd. (Automatic Electric Co.). March 5th.
7,220. "Devices for registering telephone calls." W. H. H. Green. March 5th.
7,226. "Electric light generators for bicycles, &c." X. Bullinger. March 5th.
7,241. "Electric generators." J. M. Torrance and J. W. Torrance. March 7th.
7,276. "Electric blasting caps." A. L. Oliver. March 7th.
7,285. "High-tension electric condensers." P. Bunet. March 7th. (France, May, 18th, 1920.)
7,287. "Sparking plugs." B. B. Weatherill. March 7th.
7,293. "Electric relays." Metropolitan-Vickers Electrical Co., Ltd. March 7th. (United States, May 4th, 1920.)
7,294. "Electric burglar alarms." J. Becker. March 7th.
7,297. "Electro-deposition of metals and resulting products." C. P. Madsen. March 7th.
7,303. "Earthing and bonding clip for electric circuits." C. J. H. Stevens. March 7th.
7,304. "Reversing contactors." A. West and A. West & Co., Ltd. March 7th.
7,307. "Magneto-electric machines." C. F. Dufaux and E. C. R. Marks (Dufaux). March 7th.
7,325. "Telephone systems." F. W. Davis and Relay Automatic Telephone Co., Ltd. March 7th.
7,326. "Telephone exchanges." G. H. Bryant, B. B. Johnson and Relay Automatic Telephone Co., Ltd. March 7th.
7,327. "Telephone systems." Relay Automatic Telephone Co., Ltd., and F. M. Ward. March 7th.
7,328. "Telephone exchanges." B. B. Johnson and Relay Automatic Telephone Co., Ltd. March 7th.
7,329. "Telephone exchanges." B. B. Johnson and Relay Automatic Telephone Co., Ltd. March 7th.
7,330. "Telephone systems." B. B. Johnson and Relay Automatic Telephone Co., Ltd. March 7th.
7,331. "Magnetos." L. Arnal. March 7th.
7,333. "Wireless telegraphy and telephony." H. St. J. de A. Donisthorpe. March 7th.
7,340. "Safety apparatus for electric tramcars, &c." S. H. Trippe. March 8th.
7,343. "Electric lighting from dynamos, magnetos, &c." F. H. Farrer and Villiers Engineering Co., Ltd. March 8th.
7,347. "Miners' electric gas-testing safety lamp." J. Evans and R. C. Hayden. March 8th.
7,351. "Self-regulating dynamo-electric machines." Brolt, Ltd., and W. Holt. March 8th.
7,410. "Electric measuring-instruments." F. Holden. March 8th.
7,423. "Counter speaking and telegraphing systems with amplifiers." Deutsche Telephonwerke Ges. and H. A. Gill (Deutsche Telephonwerke Ges.). March 8th.
7,425. "Process of electrolytically separating chromium." E. Liebreich. March 8th. (Germany, March 8th, 1920.)
7,449. "Truck type electric switchboards." H. G. Bailey and Johnson and Phillips, Ltd. March 8th.
7,529. "Sparking plugs, &c." E. V. Murray and H. H. Murray. March 9th.
7,549. "Apparatus for testing sparking plugs." H. H. Sharpe. March 9th.
7,551. "Telephone exchange systems." Western Electric Co., Ltd. (Western Electric Co., Inc.). March 9th.
7,558. "Ignition for internal combustion engines." British Thomson-Houston Co., Ltd., and A. P. Young. March 9th.
7,559. "Electric power transmission and braking systems." British Thomson-Houston Co., Ltd. (General Electric Co.), and General Electric Co. March 9th.
7,560. "Electrical navigation of ships." Signal Ges. March 9th. (Germany, March 12th, 1920.)
7,561. "Electrical navigation of ships." Signal Ges. March 9th. (Germany, March 12th, 1920.)
7,571. "Loud-speaking telephone." Siemens & Halske Akt.-Ges. March 9th. (Germany, March 9th, 1920.)
7,573. "Sparking plugs." C. S. Thun. March 9th.
7,584. "Means for automatically varying resistance of electric circuit." E. D. Peters and Thames Paper Co., Ltd. March 9th.
7,591. "Electrically-propelled vehicles." J. E. Hamilton and Industrial Appliances, Ltd. March 9th.
7,593. "Electrically-driven ploughs." N. Kousnetzoff and G. J. Steinheil. March 9th.
7,596. "Electrical condensers." H. W. Sullivan. March 9th.
7,606. "Electric lamps." C. H. Clarke and W. E. Weekes & Co. March 10th.
7,677. "Electrical heating devices." J. H. and S. M. Carmean. March 10th. (United States, March 13th, 1920.)
7,678. "Electrical measuring devices for polyphase circuits." Metropolitan-Vickers Electrical Co., Ltd. March 10th. (United States, March 31st, 1920.)
7,684. "Telephone transmission systems." Western Electric Co., Ltd. (Western Electric Co., Inc.). March 10th.
7,692. "Electric signalling along conductors." B. Davies and Eastern Telegraph Co., Ltd. March 10th.
7,698. "Loud-speaking telephones." Siemens & Halske Akt.-Ges. March 10th. (Germany, March 10th, 1920.)
7,699. "System of connection for twin-cored connecting leads in telephone installations." Siemens & Halske Akt.-Ges. March 10th. (Germany, April 15th, 1920.)
7,703. "Commutators for dynamo electric machines." W. B. Sayers. March 10th.
7,712. "Electric arc lamps." G. Gehlhoff and Optische Anstalt C. P. Goerz Akt.-Ges. March 10th..

PUBLISHED SPECIFICATIONS.

The numbers in parentheses are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken.

1917.

3,583. "Galvanic cells." R. Schuster. March 12th, 1917. (158,911.)

1919.

17,238. "Method for receiving wireless signals." E. H. Armstrong. December 30th, 1918. (137,271.)
19,358. "Sparking plugs." W. A. Jones. August 6th, 1919. (158,919.)
20,219. "Electric couplings." Etablissements Belin. August 16th, 1919 (France, March 8th, 1919). (140,047.)
21,244. "Means for detecting proximity of submarine cables, particularly for guiding ships or for locating faults or breaks in the cable." J. C. Manson. August 29th, 1919. (158,923.)
23,510. "Aerial systems employed in wireless signalling." C. S. Franklin. September 24th, 1919. (158,927.)
24,399. "Electric and mechanical couplings or connectors." G. Suckling. October 6th, 1919. (158,930.)
24,633. "Thermostats." H. H. Grundy. October 8th, 1919. (158,931.)
24,715. "Insulating means for electrical apparatus." British Electric Transformer Co., Ltd., and J. Roothaan. October 9th, 1919. (158,932.)
25,085. "Electrical heater." B. Thomas and E. Thomas. October 14th, 1919. (158,938.)
25,509. "Electrical commutators." R. S. Dahl. October 17th, 1919 (Convention date not granted.) (133,973.)
25,609. "Core stampings for dynamo-electric machine armatures." A. W. Tomkins. October 18th, 1919. (158,954.)
27,472. "Electric trackless tramway cars." G. A. Bishop and R. A. Chadwick. November 7th, 1919. (158,962.)
28,031. "Fluid current motors." H. G. Lloyd and C. A. Spon. November 12th, 1919. (158,974.)
28,087. "Telephone receivers and ear-pieces therefor." R. L. Murray and Telephone Manufacturing Co., Ltd. November 12th, 1919. (158,978.)
28,154. "Apparatus for electrical treatment of gases." A. Mond (International Precipitation Co., Inc.). November 13th, 1919. (158,982.)
28,369. "Electro-magnetic relays." Automatic Telephone Manufacturing Co., Ltd., and A. E. Hudd. November 15th, 1919. (158,994.)
28,383. "Holders for electric lamps." T. H. A. Brown. November 15th, 1919. (158,996.)
28,390. "Electrical heating devices." M. S. Parnell-Smith. November 15th, 1919. (158,997.)
28,491. "Aerial systems for wireless signalling." C. S. Franklin, W. J. Picken, and J. G. Robb. November 17th, 1919. (159,003.)
29,400. "Ejector condensing apparatus." A. E. L. Scanes and Metropolitan-Vickers Electrical Co., Ltd. November 25th, 1919. (159,034.)
29,215. "Variable-pressure control for circuits operated from batteries and other multiple unit sources." L. Murphy and Edison Accumulators, Ltd. December 3rd, 1919. (159,055.)
30,479. "Cooling or ventilation of dynamo-electric machines." G. Schroeder. December 5th, 1919. (159,061.)
30,680. "Collectors of electric locomotives." Sir J. A. F. Aspinall. December 8th, 1919. (159,063.)
30,941. "Devices for securing electric fittings and the like." G. H. Scholes and E. A. Claremont. December 10th, 1919. (159,070.)
31,651. "Electrical signalling and indicating devices for ships and other vessels." R. S. O'Neil. December 17th, 1919. (159,077.)
32,060. "Telegraph and telephone insulators." Taylor, Tunnicliff & Co., Ltd., and E. D. M. Scrivener. December 22nd, 1919. (159,078.)

1920.

1,821. "Electric switches." L. Moser. April 19th, 1919. (142,076.)
1,966. "Electric switches." L. Moser. January 21st, 1920. (Addition to 142,076.) (159,087.)
5,435. "Controlling device for rotary electric switches and the like." Landers, Frary & Clark. November 1st, 1918. (139,475.)
7,867. "Electric light distribution devices, decorative plaster work, and the like." C. G. Smith. March 17th, 1920. (159,100.)
8,081. "Production of electric oscillations." Western Electric Co., Ltd. June 4th, 1917. (140,449.)
13,700. "Electro-magnetic switches." Igranic Electric Co., Ltd. (Cutler Hammer Manufacturing Co.). May 18th, 1920. (159,111.)
13,767. "Improvements in electrically-heated articles to avoid damage through overheating." G. H. Lofts. May 19th, 1920. (159,112.)
19,165. "Arrangement for the electrical long-distance control of the valve-gear of a hydraulic gun-pointing gear." F. Krupp Akt.-Ges. November 27th, 1916. (147,126.)
23,899. "Telephone and like circuits." Western Electric Co., Ltd. (Western Electric Co., Inc.). November 27th, 1919. (Divided application on 155,698, addition to 155,698.) (159,122.)